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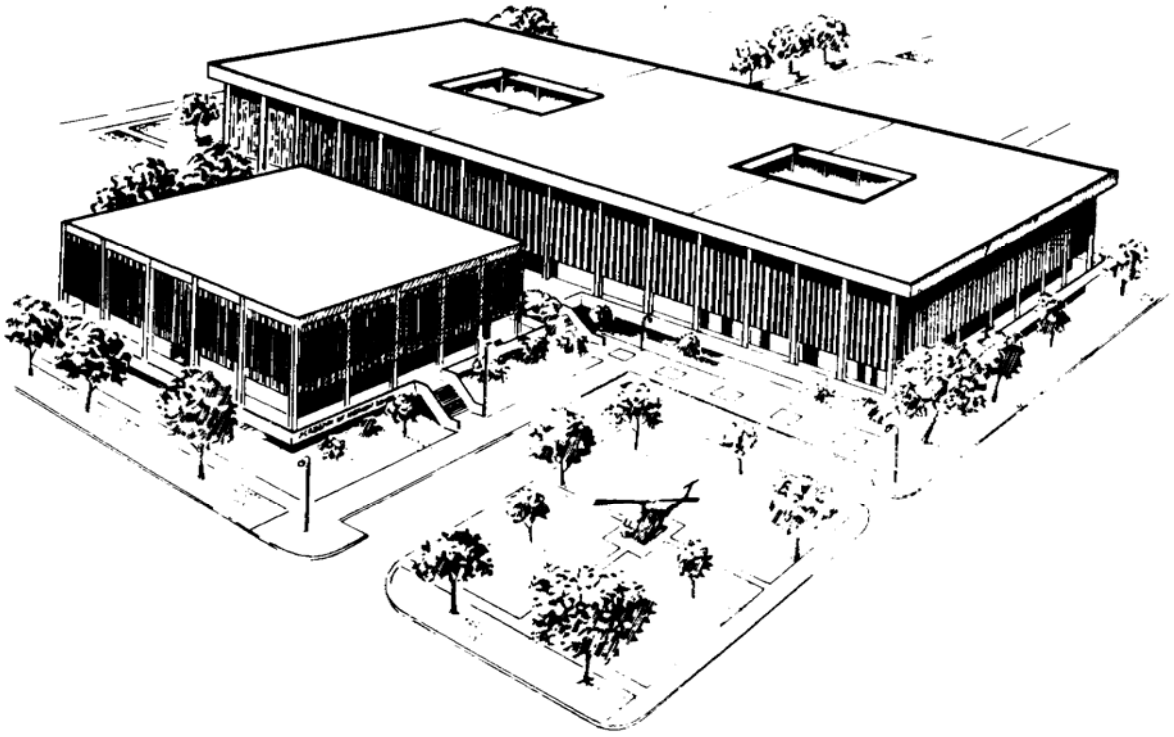
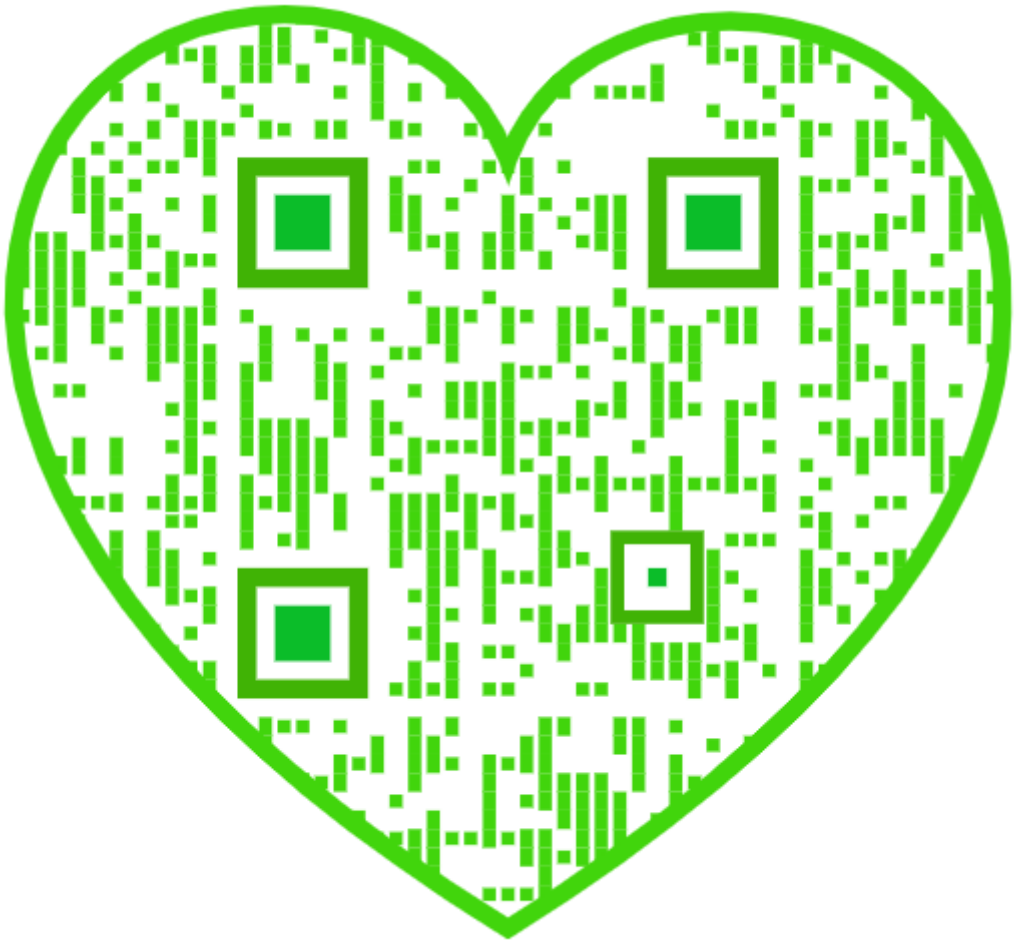


# WOUND CARE

## SUBCOURSE MD0576 EDITION 200



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**CORRESPONDENCE COURSE OF**
**THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL**

**SUBCOURSE MD0576**

# WOUND CARE

## INTRODUCTION

In this subcourse, you will study wound healing and wound care, contaminated wounds, and burns. Information you read in this subcourse will aid you in maintaining and improving the health of soldiers. In that pursuit, do your best to achieve the objectives of this subcourse.

**Subcourse Components**:

The subcourse instructional material consists of three lessons as follows:

Lesson 1, Wound Healing and Wound Care.
Lesson 2, Contaminated Wounds.
Lesson 3, Burns.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

**Credit Awarded**:

Upon successful completion of the examination for this subcourse, you will be awarded 4 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Section at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

## LESSON ASSIGNMENT

| | |
|---|---|
| **LESSON 1** | Wound Healing and Wound Care. |
| **LESSON ASSIGNMENT** | Paragraphs 1-1--1-6. |
| **LESSON OBJECTIVES** | After completing this lesson, you should be able to: |
| | 1-1. Identify terms and definitions relating to wounds. |
| | 1-2. Identify physiological responses to injury. |
| | 1-3. Describe procedures for general wound care. |
| | 1-4. Describe procedures for specific wound care. |
| | 1-5. Describe the steps of wound healing. |
| **SUGGESTION** | After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives. |

## LESSON 1

## WOUND HEALING AND WOUND CARE

### 1-1. WOUND TERMINOLOGY

a**. Definitions.** A wound is a break in the continuity of the skin, the break caused by violence or trauma to the tissue. A wound may be open or closed. In a closed wound or bruise, the soft tissue below the skin surface is damaged, but there is no break in the skin. In an open wound, the surface of the skin is broken. Here are some terms referring to wounds that you should become familiar with.

(1) Abrasion. In this type of wound, the outer layers of skin or mucous membrane are rubbed or scraped off (figure 1-1).

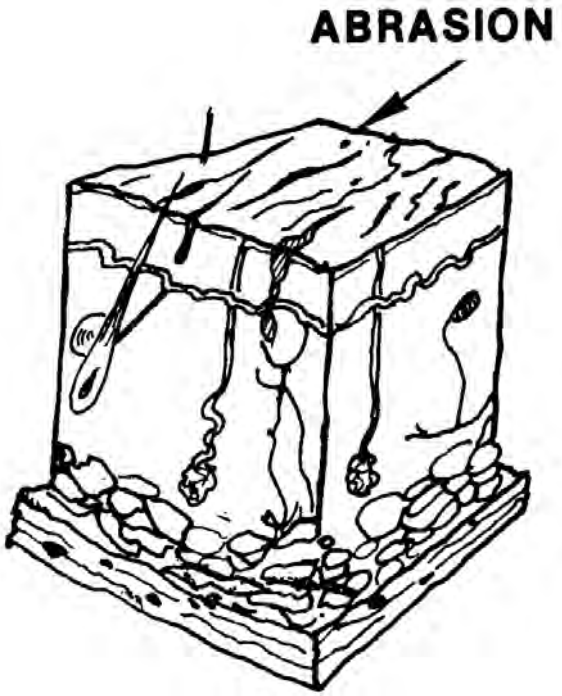


Figure 1-1. Abrasion.

(2) Incised. This type of wound is cut smooth and straight. The rate of bleeding varies and there is minimal contamination. A surgeon makes this type of wound (incision).

(3) Laceration. This wound is a torn, jagged cut which has gone through the skin tissues and blood vessels (figure 1-2). The wound can be made by blunt instruments such as shell fragments. Lacerations are usually very dirty.

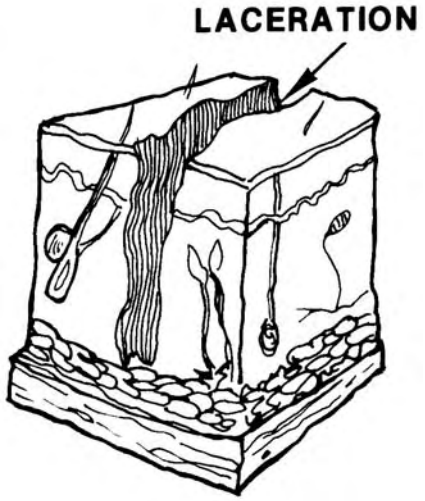


Figure 1-2. Laceration.

(4) Puncture. A puncture wound (figure 1-3) is made by a sharp object such as a splinter, knife, nail, or some other pointed object. These wounds bleed very little although the object may pass through nerves, bones, and organs, causing internal damage. Puncture wounds are usually very dirty.

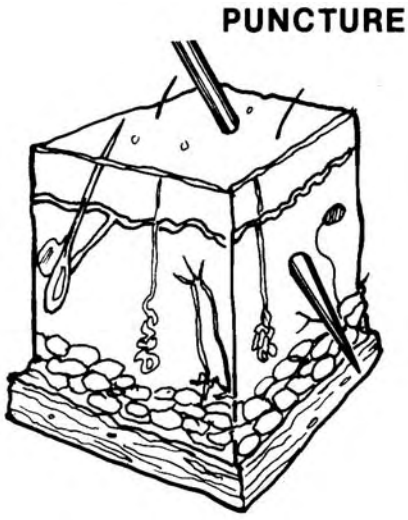


Figure 1-3. Puncture.

(5) Perforating. A perforating wound is one in which there is an entrance and/or an exit. Such a wound might be made by a bullet.

(6) Mutilating. This is the term for wounds which result in disfigurement or loss of a body part.

(7) Contusion. This wound is caused by a blunt object. The damage is done to underlying tissues or organs, and the wound is closed with no broken skin (figure 1-4).

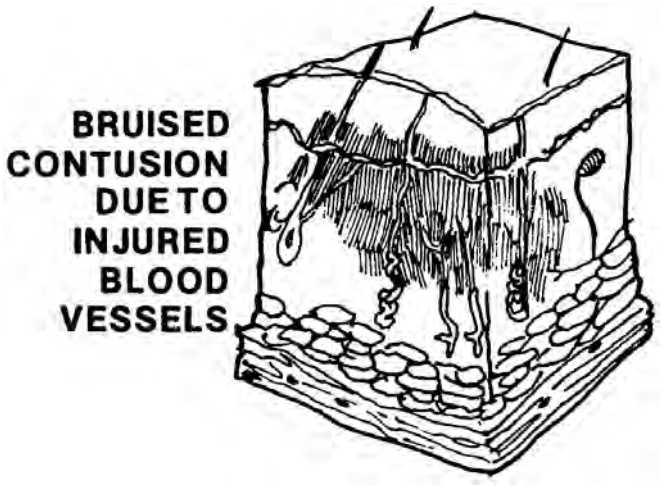


Figure 1-4. Contusion.

b. **Wound Healing.** Wound healing is a complicated process. A wound is a break in the continuity of tissue. The body must have a special procedure to take care of the skin injury and dead tissue. The injured area must be able to signal distress, and there must be some way to get rid of the dead cells and replace them with new cells. The process of wound healing is a way of restoring living tissue so that the entire body is covered with skin.

(1) The body's first response to cell damage is inflammation. The reaction is similar regardless of the cause--cut, burn, bruise, or pinch. The injury starts a reaction which may be the release from the dead or injured cells of one of their substances such as histamine. The released substances affect the capillaries. The capillaries dilate, widely increasing the blood supply that they can bring to the injured area. If the injury takes place in the skin or in the tissue close to the skin, the increased amount of blood in that area causes the area to look red. Because the injured area has a greater blood supply than the surrounding area, the wound site is warm to the touch.

(2) As the capillaries dilate, the "mesh" of their walls also is opened. Normally, capillary walls allow water and electrolytes to pass through, but now these walls also permit extra fluid and some protein plasma to escape. This extra fluid in tissue spaces produces swelling. Because the fluid is extra, the patient feels discomfort and a throbbing sensation. Sometimes just the swelling is enough to stimulate the pain receptors. The changes in the blood vessels are responsible for the basic symptoms of inflammation: swelling, pain, redness, and heat.

(3) One of the substances released by injured cells attracts leukocytes. Leukocytes pass through capillary walls into damaged tissues. In an injury with extensive tissue damage, large amounts of the substance which attracts leukocytes are released. This substance may be absorbed and circulated in the blood stimulating the production of more white cells. If a blood count is taken at this time, there will be an increase above normal in the number of white cells (leukocytosis).

(4) Inflammation is sometimes accompanied by fever. It is not clear how inflammation influences the body's temperature-regulating center. It is possible that a substance absorbed from the injured cells is the signal that stimulates the response of fever.

(5) Although the effects of inflammation are uncomfortable, they may actually prove beneficial. Protein escapes into damaged tissue and forms a gelatin type substance; this substance keeps materials from moving out of the wound site into the rest of the body. The patient experiences swelling and pain, both of which encourage him to be rather quiet and rest the injured area. This keeps infection in the injured area from spreading to other parts of the body. Bacteria, or a substance such as a foreign chemical, could harm other tissues if spread by activity to other parts of the body.

(6) Signs and symptoms of inflammation are so easy to see that inflammation attracts a great deal of attention. A doctor relies on inflammation to help locate and identify the place and type of body injury. It is possible to decide whether the body is overcoming the problem or needs additional help by watching the sequence of inflammation symptoms.

c. **Complications.** Wound complication refers to anything abnormal in the healing process. The term also refers to the loss of function of a body organ, the function loss caused by the initial wound. Infection is the single most common wound complication. Other complications of wound healing include continued bleeding, dying tissue, and improper healing.

(1) Continued bleeding. Bleeding must be stopped to allow the healing process to proceed.

(2) Dying tissue. Tissues at the site of severe injuries may have been severely damaged by being deprived of their blood supply with its oxygen and nutrients. These tissues will die and must be removed or carried away in the capillaries for healing to take place properly.

(3) Results of improper healing.

(a) A keloid is excessive scar tissue growth. It can appear in an area of injury, looking like a smooth overgrowth of fibroblastic tissues (tissues composed of spindle-shaped cells). Keloids occur primarily in dark-skinned people, but given the proper conditions, anyone can develop a keloid. Keloids can be removed surgically for cosmetic reasons.

(b) A localized infection in which there is an accumulation of pus is an abscess. Pus is a liquid accumulation of phagocytes (also called leukocytes). An abscess is caused by an infecting microorganism. The particular microorganism determines whether the pus is white, yellow, pink, or green.

(c) Inflammation of the cellular tissue surrounding the wound is cellulitis.

(d) If pus collects in an already existing cavity such as the gallbladder or lung, the term used is empyema.

(e) A fistula is an abnormal passage between two internal organs. A wound that heals improperly can cause this passage.

d. **Anemia.** In anemia, hemoglobin levels are lower resulting in tissue hypoxia (abnormally low amount of oxygen in the body tissues). This changes collagen synthesis and epithelialization, both functions in the healing process. The body compensates by increasing blood circulation in a person with mild anemia. If the volume percentage of red blood cells in the whole blood drops below 20 percent, the lower oxygen tension in the tissues can disrupt local metabolism for cell regeneration.

e. **Immunosuppression.** When a wound to the body occurs, inflammation is the immediate response. Body tissue around the wound becomes red, swollen, a little hot, sometimes painful, and sometimes there is a loss of function in that body part. Immuno-suppression is a change, in a negative way, of the body's response to a foreign substance. The body produces fewer, poorer quality leukocytes (white blood cells), fewer immunoglobulins (proteins functioning as specific antibodies), or a lesser ability for collagen synthesis. All of these are necessary for tissue repair.

f. **Foreign Body in the Wound.** A foreign body in a wound serves as a focal point for infecting microbes or preventing tissue granulation (formation of small, fleshy masses on the surface of a healing wound). Heart pacemakers and artificial legs, for example, are necessary but also qualify as foreign objects that can harbor micro-organisms and cause infection. Sutures (stitches used in surgery to unite two surfaces) also qualify as foreign substance and can be the source of infection. Sutures that are too tight can also cause a wound to heal improperly. The sutures can disrupt the collagen network, compromising the tensile strength. After the scab shrinks, the final scar is wider than normal.

g. **Blood Supply.** Since blood supplies the products used in healing, any factor which restricts blood circulation to a wound area interferes with healing. Dead or edematous tissue, restrictive bandages, and damaged arteries can all slow the healing process.

## 1-2. PHYSIOLOGICAL RESPONSES TO INJURY

Once the skin and tissue have been injured, the process of healing begins. Many factors influence the body's ability to grow new tissue.

a. **Age.** Very young and very old people heal more slowly than those in other age groups. People in these age groups have less ability to fight infection, and fighting infection is a major part of the healing process. The endocrine functions in infants are sluggish, and infants have limited reserves of fat, glycogen, and extracellular water--all which are necessary to fight infection. Healing is slower in the elderly because cardiovascular, renal, pulmonary, and musculoskeletal functions may be slowed down by chronic disease or perhaps just by the wearing out of body parts.

b. **Malnutrition.** Malnourishment and obesity, both forms of malnutrition, affect wound healing. A person who is undernourished has less fat and carbohydrate reserve; therefore, body protein (necessary for wound healing) must be used to provide energy needed for basic metabolic functions. This results in an imbalance of nitrogen which in turn depresses fibroblastic synthesis of collagen, the connective tissue for scar formation. A person suffering from Vitamin C deficiency may not be able to produce fibroblast causing a delay in wound healing. In obese individuals, fatty tissue may keep foreign matter from being seen. Fatty tissue has relatively few blood vessels, causing such tissue to separate easily. Tissue which separates easily heals slowly.

c. **Abnormalities in Endocrine Function.** Healing is slower if there are such abnormalities. In a person suffering from chronic vascular changes, the injured tissues of the wound may not get enough blood to heal at a normal rate. Persons having corticosteroid therapy will find that wounds heal more slowly.

d. **Hormone Production and Carbohydrate Metabolism.** The combined effect of the increased hormone production is to increase the metabolism of carbohydrates. The metabolism of carbohydrates is important in the body's response to trauma. If the body's store of carbohydrates is depleted (severe crush injuries, starvation), the body will begin to use fats and proteins in place of carbohydrates. Eventually, there will not be enough carbohydrates to aid in the healing process.

## 1-3. GENERAL WOUND CARE

a. **Immediate Care.** Initially, control the bleeding from the wound. Nature usually stops bleeding. For example, a person cuts his finger. Blood will gush from the lacerated blood vessels. These vessels constrict which tends to lessen the bleeding. The clotting process also stops bleeding. When blood escapes from an artery or vein, the blood undergoes changes which cause it to clot. The blood clot seals off the injured blood vessels, and bleeding stops. If the wound is large or clotting does not occur, apply direct pressure over the wound to stop bleeding. Use sterile pads if possible, but if they are not available, use a handkerchief, clean cloth, or even a bare hand as a last resort. Then, check the entire body for injuries.

b. **General Evaluation.** Make a general evaluation of the patient. Take care of him as a whole. Examine the patient from head to toe, checking for associated injuries. Follow the guidelines given below.

(1) Check his entire body for injuries.

(2) Ensure the airway is secure, spinal injuries are immobilized, etc.

(3) If there is an injury in an extremity, check the distal pulse and sensation in that extremity.

(4) Obtain a history of how the wound occurred.

(5) Find out what medications the patient is taking: steroids, chemotherapeutic agents, anticoagulants, anti-inflammatory, etc.

(6) Ask if the patient has any illness or chronic diseases such as diabetes, cancer, peripheral vascular disease (PVD), or anemia. (Wound healing may be difficult for a patient with a chronic disease or illness.)

(7) Ask if he has a current tetanus immunization.

(8) Find out if the patient has any allergies.

c. **General Wound Care (Not Life- or Limb-Threatening).** Follow this procedure to care for general wounds. Begin by removing foreign bodies, then cover the wound with a sterile dressing. This is enough if immediate evacuation is possible. If evacuation is delayed, follow the procedure given below.

(1) Cover the wound and clean the surrounding area with povidone-iodine solution (dilute).

(2) Uncover the wound and irrigate it with water. Sterile water or normal saline is preferred if available, but using potable water is better than doing nothing.

(3) Irrigate repeatedly with water using a syringe and 18-gauge catheter. This will help obtain the optimal pressure required to clean the wound without using too much pressure that could cause debris to be forced deeper in the wound.

(4) Change gloves and blot the area dry with a sterile dressing.

(5) Cover the packing with a dry, sterile dressing.

(6) Clean and dress the wound every 24 hours.

d. **Wound on Extremity.** If the wound is on an arm or leg, splint the wound and elevate the arm or leg. Elevating such an extremity increases blood circulation, thus aiding in the healing process.

e. **Local Wound Procedures.** Do not suture the wound closed. Follow this procedure to care for a local wound.

(1) Cleanse the surrounding skin with surgical soap and water.

(2) Irrigate the wound profusely with sterile saline in a syringe.

(3) Apply antiseptic solution to the surrounding skin. These steps are taken in an effort to prevent infection. Skin and mucous membranes normally have microorganisms on them. To reduce the risk of transferring these microorganisms to the wound, antiseptic is used on and around the wound.

(4) Remove foreign matter and dead tissue as early as possible, preferably within the first eight hours after injury. Remove only enough skin tissue as necessary. Remove only the edges of fascia (connective tissue that covers the body under the skin). Any wound requiring more significant exploration should be evaluated by the surgeon.

## 1-4. SPECIFIC WOUND CARE

a. **Abrasion.**

(1) Description. Friction or scraping causes an abraded wound or an abrasion. This type of wound is superficial. The outer layers of skin or mucous membrane have been damaged or scraped off. A person falling on his knees on a sidewalk will suffer an abrasion.

(2) Treatment. Treat as follows:

(a) Irrigate the wound as previously stated.

(b) Apply antibiotic ointment such as bacitracin.

(c) Cover the wound with a dry, sterile dressing.

b. **Contusion.**

(1) Description. A contusion or contused wound occurs as a result of a blow from a blunt instrument, such as a hammer. There is no break in the skin.

(2) Treatment. First apply cold compresses for 12 hours. Pad the affected area and wrap an ace bandage around the area snugly. If the area is on an arm or leg, elevate the arm or leg. Use R.I.C.E.--Rest, Ice, Compression, Elevation.

c. **Puncture/Perforation.**

(1) Description. A wound made by a pointed instrument such as a nail, wire, or knife can result in a puncture or perforation wound. Sometimes a scalpel is used by a doctor to make a puncture wound to promote drainage from tissues. A wound caused by an animal or insect sting, the wound breaking the skin surface and underlying tissues, is also called a puncture wound.

(2) Treatment. These wounds have a higher potential for infection because pathogens and particles of debris have been introduced deep into the tissue. If these wounds are not treated properly, the patients may come for treatment 24 to 48 hours after the injury with complaints of local pain, malaise, and fever. To treat these wounds properly, follow the guidelines given below.

(a) For uncontaminated wounds, irrigate the injured site with normal saline solution. Apply a topical antibiotic such as bacitracin.

(b) For contaminated wounds, have the wound evaluated by the surgeon.

d. **Incision/Laceration**.

(1) Description. An incision occurs as a result of a cut by a sharp instrument. An example of an incision is a cut made with a scalpel during surgery. In this type of wound, the wound edges are smooth. In a laceration, the tissues are torn apart and remain jagged and irregular. A wound made by the cut of a saw will be a laceration. Although the two types of wounds look and are different, treatment for both is about the same.

(2) Laceration classification. Lacerations can be further classified into four categories: shear lacerations, tension lacerations, compression lacerations, and combination lacerations.

(a) Shear lacerations are caused by sharp objects such as a knife, blades, etc. Little damage is done to the tissues adjacent to the wound. This type of laceration heals rapidly. There is minimal scarring due to the health of the tissues at the edges of the wound.

(b) Tension lacerations are caused when the skin strikes a flat surface and rips. The rip occurs because the impact causes stress on tissues. In this laceration, there is no bone directly below the region of the skin that is struck. Tension lacerations heal with more scarring because of bruising of soft tissue around the laceration. For example, an individual falls on the palms of his hands to break a fall. He may sustain a ragged, linear laceration on the palm of his hand, a tension laceration.

(c) In compression lacerations, tissue is caught between the bone and an external hard surface. Caught in such a manner, the skin bursts. These lacerations heal with the greatest degree of scarring. The reason is that the skin next to the laceration is injured. An individual walking along a sidewalk trips and falls. In the fall, his forehead hits the pavement. He will likely have a compression laceration.

(d) Combination lacerations are as the name suggests, a combination of different types of lacerations. Imagine this. A person hits a bony prominence against a table. He sustains a linear laceration as in a shear injury. The wound edges, however, are crushed as in a compression injury. The combination is shear laceration and compression laceration.

(3) Treatment. Be sure you have good lighting and that you use aseptic technique. Irrigate and mechanically debride the wound. Then, use one of these three types of closure: primary closure, secondary closure, or tertiary intent closure.

(a) Primary closure is the term for a wound that is repaired immediately after the injury. Use sutures, skin tapes, staples, or tissue adhesives such as steri-strips and butterflies to cover the wound. For example, a child falls down and skins his knee. The wound is cleansed and a bandage applied over it. This is primary closure. Wounds treated in this manner heal fastest and with the best cosmetic results; that is, with little or no scarring. Primary closure is the treatment of choice for any wound that is not infected or grossly contaminated. Most lacerations closed in this manner must be done within eight hours from the time of the injury.

(b) Secondary closure is the term for wounds which are allowed to granulate on their own without surgical closure. Clean and prep the wound in the usual manner, then cover the wound with a sterile dressing. Secondary closure is used for certain kinds of wounds such as fingertip amputations or partial thickness tissue loss.

(c) Tertiary intent closure is the process of cleaning and dressing a wound initially, but not closing the wound. The patient returns for definite closure in three to four days. Tertiary intent closure is also called delayed primary closure. This is the method of choice for repairing contaminated lacerations that would leave unacceptable scars if not closed. This method can also be used for patients who did not seek immediate care for their lacerations.

NOTE: The body's skin tension lines are important in wound closure. Pinch your skin together and you can see lines or creases that naturally occur in the skin. The configuration of creases is different in various parts of the body. A laceration that follows the lines will heal with less scarring than a laceration that runs across the lines. Other names for these lines are cleavage lines and Lines of Langer.

e. **Impaled Foreign Object.** An impaled object in a puncture wound requires careful treatment. A knife, a steel rod, a glass shard, or any number of other objects can be impaled. General treatment rules are given below.

(1) **DO NOT** remove the impaled object. Removing it may cause severe bleeding if the object was exerting pressure on severed blood vessels. Removing the object could also cause additional injury to muscles, nerves, and other soft tissues.

(2) Carefully expose the wound area; that is, cut clothing away so that you can see the wound site. Be very careful not to disturb the impaled object as you do this. **DO NOT** lift clothing over the impaled object. If the impaled object is long, stabilize it by hand while you are trying to expose the wound, control bleeding, and dress the wound.

(3) Control profuse bleeding. Place your hand so that your fingers are on either side of the impaled object and use your hand to exert pressure down. If the impaled object has a sharp edge (a glass shard or a knife, for example), be careful in exerting pressure. You do not want to injure the patient further or cut your hands.

(4) Stabilize the impaled object. As another person stabilizes the impaled object, put several layers of bulky dressing around the injury site. Make sure the impaled object is surrounded by dressings on all sides.

(5) Secure the dressings. Use adhesive strips to hold the dressings if the area around the wound site is free enough from blood and sweat so that adhesive sticks to the skin. Use cravats if adhesive will not stick to the skin. Tie one cravat above the impaled object and one below the impaled object.

(6) Treat for shock, if necessary.

(7) Keep the patient quiet and give emotional support.

(8) Evacuate the patient to a medical treatment facility.

NOTE: Impaled objects in the eye or cheek require special procedures.

f. **Animal Bites.** An animal's mouth is heavily contaminated with bacteria. Serious infection may result if the bite occurs on the hand or face. Treat an animal bite in the following manner.

(1) Wash the bite vigorously with soap and water for at least 10 minutes. This is done to remove the animal's saliva.

(2) Flush the wound with water.

(3) Apply a sterile dressing (if the wound is in a location that you can do so).

(4) **DO NOT** suture the wound unless you must do so to stop profuse bleeding.

(5) **DO NOT** stop bleeding right away unless it is profuse. The flow of blood helps to cleanse the wound.

(6) Evacuate the patient to a medical treatment facility for tetanus toxoid and rabies precautions, as necessary.

## 1-5. STEPS OF WOUND HEALING

a. A wound occurs and the elasticity of the skin and spasm of muscle cause the initial wound to become larger. The healing process begins. A blood clot forms, contracts, dries, and forms a scab. This is the first protective covering of the wound. Next, the inflammation process begins. In the inflammation process, the blood supply to the injured area increases and substances of leukotoxin and histamine are released by the injured cells to promote repair and regrowth of tissues. Leukotoxin draws white blood cells to the area; these cells destroy and remove foreign substances. Histamine and other substances increase the permeability of the capillary walls allowing fluids, proteins, and white blood cells to move into the injured area. Inflammation is the best environment for wound healing. A problem occurs only if foreign matter remains in the wound.

b. Twelve hours after injury, epithelialization begins. In this phase of wound healing, epithelium forms over the wound. If the wound is superficial, epithelium forms in a few hours. In a deep wound, epithelialization may take days or weeks. At the same time granulation tissue is present, tissue made of fibrous-collagen and capillary loops. This tissue provides excellent protection from infection. At this stage, the wound appears pink (due to the new capillaries in the granulation tissue), and the area is soft and tender. Collagen, a supportive protein component of skin, changes from a liquid to a gel to scar tissue. The wound becomes stronger for seventeen days at which time 90 percent of the wound's strength has been regained.

## 1-6. CLOSING

Healing is a natural process, the mechanism through which the body repairs or replaces damaged tissue. Many wounds need help to heal properly or at all. Your knowledge of proper wound care and treatment may determine how well a wound heals, from a cosmetic standpoint as well as from a health standpoint. To this end, it is important for you to be thoroughly knowledgeable in the most effective means to care for wounds and to prevent wound infection.

**Continue with Exercises**

**EXERCISES, LESSON 1**

**INSTRUCTIONS.** The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. A wound is _____

   _____.

2. A closed wound caused by a blunt object with damage to underlying tissues or organs is a(n) _____.

3. The casualty has a bullet wound, a wound with an entrance to his body and an exit from his body. This wound is a(n) _____ wound.

4. A(n) _____ wound is one which is made by a sharp object.

5. A wound which is cut smooth and straight is a(n) _____.

6. A wound which has torn, uneven edges and has been caused by a blunt instrument such as a shell fragment is a(n) _____.

7. The patient has been injured in an accident which resulted in disfigurement. This wound is classified as a(n) _____ wound.

8. There is some edema around the wound site and the patient is experiencing some pain. These two conditions are causing him to be rather quiet, resting the wound area. How is the quiet and rest beneficial to the healing process?

_____

_____

9. Anything abnormal in the healing process is referred to as wound _____.

10. The single most common wound complication is _____.

11. What is a keloid? _____

12. Increased blood supply to the wound promotes healing. List three causes of restricted blood supply to a wound:

a. _____.

b. _____.

c. _____.

13. List four factors that influence the body's ability to grow new tissue.

a. _____.

b. _____.

c. _____.

d. _____.

14. List two reasons why wound healing may be slower in an obese individual.

    a. _____

    _____

    b. _____

    _____

15. In general wound care, begin by _____, then cover the wound with a sterile dressing.

16. List three steps in the treatment of a contusion.

    a. _____.

    b. _____.

    c. _____.

17. The patient has a wound on his leg. After treating the wound, you elevate his leg. How does elevating the leg help in the healing process?

    _____

    _____

18. Treat an abrasion in three basic steps.

    a. _____.

    b. _____.

    c. _____.

19. An uncontaminated puncture wound should first be treated by _____

    _____. Then,_____.

20. The process of cleaning and dressing a laceration initially, but not closing the wound is called _____ closure.

21. In the inflammation step of wound healing,_____ rushes to the injured area. Also in this step, injured cells release two substances which promote repair and regrowth of tissues. List these substances.

a. _____.

b. _____.

22. White blood cells are drawn to a wound area. List two ways these cells contribute to wound healing.

a. _____.

b. _____.

23. Histamines increase the permeability of capillary walls in the wound area. Name three substances which can flow through capillary walls to the injured area.

a. _____.

b. _____.

c. _____.

24. What changes does skin protein collagen go through in the wound healing process?

_____.

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 1

1. A break in the continuity of the skin caused by violence or trauma to the tissue. (para 1-1a)

2. Contusion. (para 1-1a(7))

3. Perforating. (para 1-1a(5))

4. Puncture. (para 1-1a(4))

5. Incision. (para 1-1a(2))

6. Laceration. (para 1-1a(3))

7. Mutilating. (para 1-1a(6))

8. The rest and quiet keeps infection in the injured area from spreading to other parts of the body. (para 1-1b(5))

9. Complication. (para 1-1c)

10. Infection. (para 1-1c)

11. A keloid is excessive scar tissue growth. (para 1-1c(3)(a))

12. Dead or edematous tissue.
    Restrictive bandages.
    Damaged arteries. (para 1-1g)

13. Age
    Malnutrition
    Abnormalities in endocrine function
    Hormone production and carbohydrate metabolism. (para 1-2a through d)

14. Foreign matter in the wound may not be able to be seen because it is buried in fatty tissue.
    The relatively few blood vessels in fatty tissue cause such tissue to separate easily. Tissue which separates easily heals slowly. (para 1-2b)

15. Removing any foreign bodies. (para 1-3c)

16. Apply cold compresses for 12 hours.
    Pad the affected area.
    Wrap an ace bandage around the area snugly. (para 1-4b(2))

17. Elevating the injured leg increases the flow of blood to the leg. The increased blood promotes healing. (para 1-3d)

18. Cleanse the wound.
Apply ointment such as bacitracin.
Cover the wound with a dry, sterile dressing. (para 1-4a(2))

19. Irrigating with normal saline.
Applying a topical antibiotics. (para 1-4c(2))

20. Secondary. (para 1-4d(3)(b))

21. Blood.
Leukotoxin.
Histamines. (para 1-5a)

22. White blood cells destroy foreign substances.
White blood cells remove foreign substances. (para 1-5a)

23. Fluids.
Proteins.
White blood cells. (para 1-5a)

24. Collagen changes from a liquid to a gel to scar tissue. (para 1-5b)

**End of Lesson 1**

## LESSON ASSIGNMENT

| | |
|---|---|
| **LESSON 2** | Contaminated Wounds. |
| **LESSON ASSIGNMENT** | Paragraphs 2-1--2-5. |
| **LESSON OBJECTIVES** | After completing this lesson, you should be able to: |
| | 2-1. Identify the factors responsible for infection. |
| | 2-2. Identify the cardinal signs and symptoms of wound infection. |
| | 2-3. Identify the characteristics, signs and symptoms, and treatment for gram-positive organisms. |
| | 2-4. Identify the characteristics, signs and symptoms, and treatment for gram-negative organisms. |
| **SUGGESTION** | After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives. |

## LESSON 2

## CONTAMINATED WOUNDS

### 2-1. INTRODUCTION

Many factors can and do contribute to infection in injuries. Some of these are beyond your control, but, in many circumstances, you can directly prevent complications and sometimes ultimately influence survival by knowledge of the factors involved in a wound infection.

### 2-2. FACTORS RESPONSIBLE FOR INFECTION

Infection is a condition in which the body or a part of it is invaded by a disease-producing organism. This organism multiplies under favorable conditions and produces injurious effects to the body. All wounds harbor organisms. Additionally, many organisms are present in the air. Immediately after a wound is opened, organisms can enter it. The presence of organisms in a wound does not necessarily mean that there will be an infection. Other factors are involved in the development of an infection. Some are listed below.

a. Delay in treatment.

b. Decreased blood circulation because of shock.

c. Collection of blood in the wound and surrounding tissues. This collection, called hematoma, restricts circulation.

d. Location of the wound. Areas of the body with a good blood supply are less likely to become infected. Wounds on legs, which have a poorer blood supply, are more likely to become infected.

e. Retention of foreign bodies in the wounds.

f. Inadequate irrigation or inadequate removal of dead tissue.

g. Suturing of dirty wounds.

h. Inadequate immobilization.

i. Breaking sterile technique and cross contamination.

j. Presence of bacteria that are resistant to antibiotics.

k. Secondary disease. Persons with diabetes, arteriosclerosis, and anemia, as well as some other diseases, find that their wounds heal more slowly.

## 2-3. CARDINAL SIGNS AND SYMPTOMS OF WOUND INFECTION

A patient who has an infected wound may show symptoms at the wound site and also have general symptoms. Symptoms at the wound site are caused by the inflammation process. The generalized signs and symptoms of infection are the body's response to infection. The degree to which a person shows some or all of these symptoms depends greatly on how severe the infection is and how much resistance to infection a person has. Some signs and symptoms of wound infection are listed below.

a. Signs and symptoms of wound infection at the wound site include the following.

(1) Pain and tenderness.

(2) Redness and swelling.

(3) Increased local temperature.

(4) Formation of pus.

(5) Cellulitis. In this condition, infection spreads through the subcutaneous layer of skin. Signs and symptoms include edema, (fluid retention), erythema (redness), warmth, and local pain.

(6) Lymphangitis/lymphadenitis. This is inflammation of the lymph channels and nodes indicated by red streaks leading away from the wound.

(7) Local infection has a defined area while infection that is spreading is ill-defined with obvious involvement to the surrounding area.

b. Involvement of the entire body is evidenced by fever and possible chills.

## 2-4. GRAM-POSITIVE ORGANISM

a. **General.** It is difficult to identify microorganisms under a microscope unless they have been stained. Hans Christian Gram, a Danish histologist, developed the Gram stain procedure in 1884, a procedure used universally. Bacteria are classified as either positive or negative, depending on their stain reaction. An organism that takes up and retains the crystal violet stain will appear purplish under the microscope; these are gram-positive organisms. Other organisms will retain the pink or red counterstain, safranin. These organisms are known as gram-negative.

b. **Staphylococcal Infections.**

(1) Signs/symptoms. The basic symptoms of swelling, pain, redness, and heat at the infection site are present. There may be abscess formation at the site also. Initially, the abscess will be firm; then it becomes yielding when touched, indicating that the center is full of liquid (pus). The abscess will often drain spontaneously and thick yellow or cream colored pus will come out. Lymphadenitis (inflammation of the lymph glands) and lymphangitis (inflammation of the lymphatic vessels) are both common manifestations of staphylococcal infections.

(2) Treatment. Have the patient rest and elevate the affected area. Apply moist, warm compresses to promote the healing process. In a relatively small, recent wound, this treatment will usually be sufficient. If the wound is large and purulent, complete these first two steps, then make an incision and drain the wound. Squeeze out any exudate in the wound. Irrigate the wound with normal saline solution and/or antiseptic solution such as povidone-iodine. Clean the wound thoroughly, being sure all foreign matter and exudate has been removed. Dress the wound with sterile gauze packing. Use iodoform gauze to stuff down in the wound with just the tip (the wick) sticking up. This gauze will soak up the exudate which will be made as part of the healing process. The wick is to allow the person changing the dressing to remove the soiled gauze easily. Put a nonadherent cover over the wicking. (Telfa is a plastic-like coating on one side of a gauze dressing that prevents the dressing from adhering to the wound.) Be sure the dressing is changed daily.

c. **Streptococcal Infections.**

(1) Signs/symptoms. As with staphylococcal infections, the basic symptoms are swelling, pain, redness, and heat at the infection site. Generally, there is no abscess formation, but there is a rapid spread of infection from the edge of the wound outward through the skin and subcutaneous tissue.

(2) Treatment. Advise the patient to rest and elevate the affected area. Apply moist, warm compresses to promote the healing process. Always administer antibiotic therapy as directed by a physician.

d. **Gas Gangrene (Clostridium Bifermentans or Clostridium Perfringens, Class A and F.)** Gas gangrene is an infection that comes on suddenly and violently in dead tissue and spreads rapidly. The infection is caused by one of several clostridia--Clostridium perfringens, Clostridium novyi, or Clostridium speticum, for example. Moving into dead or dying tissues, these organisms use amino acids and carbohydrates from the cells. Gas is produced that stretches tissues and interferes with blood supply and oxygenation. The organisms multiply and secrete enzymes that destroy living tissues adjacent to the wound as well as red blood cells. In this way, infection continues to spread. As the organisms continue to multiply, infection accelerates and advances, making severe anemia and toxemia possible. Eventually, acute toxemia may result in shock and rapid death.

(1) Signs/symptoms. The infection begins suddenly with rapidly increasing pain in the affected area, a fall in blood pressure, and tachycardia. The patient becomes anxious and frightened with a slight fever (less than 101ºF) and profuse sweating. His pulse is elevated (greater than 120 beats per minute). The wound itself becomes swollen and the skin around the wound is pale due to accumulation of fluid under the skin. The wound has a reddish-brown discharge that is a foul-smelling fluid. As the infection progresses, the surrounding tissue changes from pale to dusky and finally becomes deeply discolored with red, fluid-filled sacs. When the skin surface is lightly touched, gas in the tissues may be felt. Eventually, the patient suffers severe prostration, stupor, delirium, and coma.

(2) Treatment. Treatment must begin immediately. Delay could mean loss of life. The most important treatment is surgical removal of any dead tissue in the involved area and airing of the wound. Keep the wound open to drain. Give penicillin intramuscularly every 3 hours and tetanus toxoid according to local standing operating procedure. Hyperbaric oxygen therapy may be helpful. In hyperbaric oxygen therapy, the patient is placed in a hyperbaric chamber, a room which contains oxygen at a concentration and pressure much higher than the normal atmosphere. The patient's bloodstream and tissues are saturated with oxygen for one to three hours at a time. Repeat this treatment every six to eight hours. Manage shock and dehydration if present and evacuate the patient.

e. **Tetanus.** Caused by the organism Clostridium tetani, tetanus attacks the central nervous system. The organism is found in the soil and feces of animals and humans. The organism enters the body through a puncture wound or pus-filled, dead tissue. Tetanus is an acute, infectious disease caused by the toxin of tetanus bacillus.

(1) Signs/symptoms. The first symptoms may be pain and tingling at the wound site followed by spasms of the muscles located close to the wound. Usually, the first symptoms are jaw stiffness, neck stiffness, dysphagia (difficulty swallowing), and irritability. Minor stimuli can cause painful, long lasting convulsions. During convulsions, the glottis and respiratory muscles may go into spasm so that the patient cannot breathe and he may die from lack of oxygen. Throughout the illness, the patient has only a low grade fever. Contraction of facial muscles may cause the patient's face to have a mask-like grin (risus sardonicus).

(2) Prophylaxis at time of injury (precautions taken to prevent the disease). A person who gets a wound and suspects that Clostridium tetani organism might be present should receive tetanus toxoid immediately. Administer 0.5 cc intramuscularly in a dosage of 25 to 500 units. The dosage depends on the seriousness of the wound, not on the age or weight of the patient. Patients who have had tetanus immunizations should be given a tetanus toxoid booster of 0.5 cc intramuscularly immediately. An exception can be made if the patient has had a tetanus toxoid booster in the last five years. In the case of a severe, puncture wound, if the patient has had a tetanus toxoid booster in the past twelve months, another tetanus booster need not be given.

(3) Treatment. Give 5000 units of tetanus immune globulin (human) intramuscularly. Give tetanus antitoxin, 100,000 units intravenously after testing for horse serum sensitivity if tetanus immune globulin is not available. Put the patient on bed rest and avoid exciting him. Take steps to maintain the airway. Administer penicillin-G or tetracycline as directed. Clean the wound thoroughly of dead tissue and foreign matter. If necessary, feed the patient by gastric tube. Insert a Foley catheter if urinary retention occurs.

## 2-5. GRAM-NEGATIVE INFECTIONS

Gram-negative organisms may be identified by using the Gram stain procedure. Examined under the microscope, these organisms retain the pink or red counterstain, safranin. Four species of bacteria most frequently cause gram-negative infections: Escherichia coli, Enterobacter, Klebsiella pneumoniae aeruginosa, and Proteus. Gram-negative bacteria invade the bodies of individuals that are not in the best of health. Persons in good health are not usually bothered by gram-negative infections.

a. **Infection Development.** Gram-negative infections develop in various parts of the body and have a variety of causes.

(1) On the skin, these infections are a form of leukemia and must be treated with chemotherapeutic agents.

(2) In the respiratory tract, these infections develop from aspiration, tracheostomy, and mechanical ventilation.

(3) In the vascular system, gram-negative infections develop from intravenous catheters, intracardiac pacemakers, venous cutdowns, pressure-monitoring devices, total parenteral nutrition, and surgical procedures.

(4) In the gastrointestinal tract, infections develop from obstruction, perforation, abscesses, and diverticuli.

(5) In the genitourinary tract, infections come from indwelling catheters, and urinary obstruction.

(6) In the reproductive system, gram-negative infections develop from abortion, and postpartum (after childbirth) period.

b. **Signs/Symptoms.** During the early stage, the skin is warm and dry. The patient may experience a shaking chill, and his temperature may rise rapidly. The patient's personality may change; his behavior may not be appropriate. Low blood pressure may be indicated by cool, clammy skin, tachycardia/tachypnea, proceeding to peripheral cyanosis, oliguria, and death as a result of vascular collapse.

c. **Treatment.** First, identify the source of infection. Collect blood cultures and obtain other smears and cultures as indicated. When possible, remove any source of possible infection such as venous or urinary catheters. Incise and drain any local infections. Prevent and treat shock by monitoring vital signs, administering IV fluids and blood, administering oxygen, and administering antibiotics.

**Continue with Exercises**

**EXERCISES, LESSON 2**

**INSTRUCTIONS.** The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. List three factors involved in the development of infection in a wound.

   a. _____.

   b. _____.

   c. _____.

2. Basic signs of infection at the wound site include pain and tenderness, redness and swelling, increased local temperature, formation of _____, and cellulitis.

3. _____ is a condition in which infection spreads through the subcutaneous layer of skin.

4. In the Gram-stain procedure, gram-_____organisms take up and retain a crystal violet stain which appears purplish under a microscope. The organisms which retain the pink or red counterstain are gram-_____ organisms.

5. In a _____infection, local abscess formations can be firm initially, become fluctuant, and then drain spontaneously.

6. A(n) _____ infection has no abscess formation, but infection spreads rapidly from the edge of the wound outward through the skin and subcutaneous tissue.

7. _____ is an infection which spreads through dead tissue.

8. Treatment for gas gangrene must be started immediately because _____.

9. The causative organism for tetanus is found in _____and in _____

10. List the four species of bacteria which most frequently cause gram-negative infections.

    a. _____.

    b. _____.

    c. _____.

    d. _____.

11. Treatment for _____ infections includes removing any possible source of infection such as venous or urinary catheters.

12. _____ is a condition in which the body, or a part of it, is invaded by a disease-producing organism.

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 2

1. You are correct if you listed any 3 of the following:
   - Delay in treatment.
   - Decreased blood circulation.
   - Collection of blood in the wound and surrounding tissues.
   - Location of wound.
   - Foreign bodies in the wound.
   - Inadequate irrigation or inadequate removal of dead tissue.
   - Suturing of dirty wounds.
   - Inadequate immobilization.
   - Breaking sterile technique and cross contamination.
   - Antibiotic-resistant bacteria in the wound.
   - Secondary disease. (para 2-2a through k)

2. Pus. (para 2-3a(1) through (5))

3. Cellulitis. (para 2-3a(5))

4. Positive.
   Negative. (para 2-4a)

5. Staphylococcal. (para 2-4b(1)

6. Streptococcal. (para 2-4c(1))

7. Gas gangrene. (para 2-4d(1))

8. Delay could mean loss of life. (para 2-4d(2))

9. Soil.
   Feces of animals and humans. (para 2-4e)

10. Escherichia coli.
    Enterobacter.
    Klebsiella penumoniae aeruginosa.
    Proteus. (para 2-5)

11. Gram-negative. (para 2-5c)

12. Infection. (para 2-2)

**End of Lesson 2**

## LESSON ASSIGNMENT

**LESSON 3** Burns.

**LESSON ASSIGNMENT** Paragraphs 3-1--3-27.

**LESSON OBJECTIVES** After completing this lesson, you should be able to:

3-1. Identify the factors for determining the severity of a burn injury.

3-2. Identify the characteristics of each of the following burns:
- Thermal burns.
- Electrical burns.
- Lightning burns.
- Chemical burns.
- Radiant burns.
- Inhalation burns.

3-3. Identify the causes, signs and symptoms, and treatment for each of the following burns:
- Thermal burns.
- Electrical burns.
- Lightning burns.
- Chemical burns.
- Inhalation burns.

3-4. Identify items which must be corrected at an electrical accident before the rescuer can aid the injured person.

3-5. Identify the criticality levels of a thermal burn.

3-6. Calculate the total body surface area (TBSA) burned using the Rule of Nines.

3-7. Calculate the amount of replacement fluid needed for a burn casualty.

**SUGGESTION** After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

# LESSON 3

# BURNS

## Section I. SEVERITY AND CAUSES OF BURNS

### 3-1. INTRODUCTION

a. **General Seriousness of Burns.** Human beings exist in an environment that contains elements which can be hazardous to our health. Excessive heat, excessive cold, dangerous chemicals, fire, and water are a few of these elements. Whatever causes burns (fire, electricity, etc.,) is of particular concern to us since burns are a major cause of accidental death. Each year more than 2,000,000 million burn accidents cause over 90,000 individuals to be hospitalized. Almost 10,000 people die from burns yearly. Injuries from burns can be painful, require many months of treatment, and involve loss of function. Burns are especially hard on children and the elderly, not only in healing but also in surviving the injury.

b. **Importance to the Armed Forces.** Today's military uses more fuel than ever before in order to provide ground and air mobility. The extensive presence of this fuel increases the risk of burns to military personnel. During conflict, there is a greater chance of these fuels igniting accidentally and causing burns to those nearby. Accidents with thermonuclear weaponry can also result in burns. Use of more fuel and the development of thermonuclear weaponry make the possibility of instant, large numbers of burn patients a medical and a logistical problem. Whether you deal with one casualty or a large number of casualties, it is most important that you have the knowledge to be able to assess the severity of a burn and treat the burn. Your actions could mean saving a casualty's life.

### 3-2. FACTORS IN SEVERITY OF BURN INJURY

A number of factors need to be considered when the severity of a burn is being determined. Some of these factors are listed below.

a. **Source of the Burn.** A burn from nuclear radiation may appear to be minor, but is probably more serious than a thermal burn. Chemical burns are serious because chemicals which remain on the skin continue to burn the skin for hours or even days. Remaining in contact with the skin, chemicals can enter the bloodstream.

b. **Degree of Burn.** If the burn penetrates the outer layer of the skin, as in second- and third-degree burns, the exposed tissues can be contaminated and invaded by harmful chemicals and microorganisms. Eventually, these chemicals and microorganisms can enter the circulatory system of the body.

c. **Percentage of the Body Burned (Body Regions Burned).** The percentage of the body burned is an important factor in the probability for patient recovery.

d. **Location of the Burn.** The areas of the body which were burned are important. A burn to the face may interfere with the airway or cause injury to the eyes. If the burn is on the groin, buttocks, or medial thighs, the potential for bacterial contamination is present.

e. **Complications Accompanying the Burn.** A patient with other illnesses (such as respiratory problems, heart disease, or diabetes) is in greater jeopardy than a normal, healthy adult when burned. A minor burn for a healthy adult may be a serious burn for a person with any one of these health problems.

f. **Age of the Patient.** Individuals in the 5 to 59 age range have the best chance for recovery from burns. Infants, children under 5, and adults over 60 have severe body reactions to burns. The healing pattern for burns is different in these age ranges of the population.

## 3-3. CAUSES OF BURNS

a. **General Information.** There are many causes of burns, such as direct contact with flames, hot liquids, chemicals, hot metals, radiation, and electrical current. One of the functions of the skin is to retain the fluids of the body. Burns can cause loss of these fluids, which can result in shock. If a burn causes blisters or skin loss, there is also a danger of infection at the burn site. Hot gas and flame burns of the neck, nose, and mouth may result in the swelling of the airway. Even minor burns in enclosed areas may cause respiratory damage.

b. **Causes of Thermal Burns.** The most common type of burns is thermal burn. Thermal burns are caused by direct contact with a heat source. Playing with matches, space heaters igniting papers or drapes in a house, and malfunction of electrical appliances can all cause thermal burns. Another cause of thermal burns is scalding hot liquid such as the hot water tap turned on by a small child in a bathtub or hot water accidentally spilled from a pot on a stove. Around holidays--particularly the Fourth of July or Christmas--individuals who handle fireworks improperly become thermal burn victims. However, the greatest number of thermal burns is caused by gasoline or other fuels bursting into flame and burning anyone who is near.

c. **Cause of Electrical Burns.** Electrical burns are caused by accidental contact with exposed parts of electrical wiring. Because we touch and grasp with our hands, the hands are the areas where electrical current most often enters the body.

d. **Causes of Chemical Burns.** Chemical burns occur when the body comes in contact with caustic substances (substances capable of burning, corroding, or destroying living tissue) such as acids, alkalis, white phosphorus, and napalm.

e. **Causes of Radiant Burns.** The word "radiation" is a general term for the process of energy being transmitted from one body through a medium or space and absorbed by another body. Radiation burns can be caused by nuclear energy, ultraviolet light, visible light, heat, sound, and x-rays. If asked to name the most common cause of radiation burns, many people would answer industrial accidents such as an accident at a nuclear energy plant. However, the most common radiation burn is probably sunburn--radiation from the sun.

## Section II. ELECTRICAL, LIGHTNING, CHEMICAL, INHALATION, AND RADIANT BURNS

### 3-4. ELECTRICAL BURNS

a. **General Effects.** Electric current passing through the body can cause severe injury to body tissues. How much tissue damage occurs depends on the strength of the electric current passing through the body and the length of time the patient was exposed to the current. Electricity is a fundamental part of our environment. Man-made electricity provides us with conveniences such as air-conditioning and pleasures such as VCRs and television. Electricity in nature gives us the beauty of the aurora borealis and lightning. However, electricity can also be dangerous. When it goes through the body, electricity is converted to heat that burns tissues in its path. High-voltage electrical current can arc, generating so much electricity that it burns a person standing nearby. Current passing through vital body organs can cause respiratory or cardiac arrest with fatal results.

b. **Determination of the Severity of an Electrical Burn.** The severity of a patient's burns is critical to the order of care he will receive, the type of care, and the order of transport. For an electrical burn patient, an accurate history of the accident should include the following elements.

(1) Voltage and amperage of the current.

(2) Amount of time the patient was exposed to the electricity.

(3) Amount of moisture on the patient.

(4) Amount of his body surface that came in contact with the current.

(5) Amount of insulation worn by the patient.

(6) Area of the body through which the current passed.

(7) Type of current (AC or DC).

c. **Signs and Symptoms of Electrocution.** A person who has had an electrical accident may have the following signs and symptoms.

(1) Burns on the skin surface where the energy entered and exited the body.

(2) Dazed and confused condition.

(3) Problems with sight.

(4) Paralysis (from disrupted nerve pathways).

(5) Irritable or restless, whether conscious or unconscious.

(6) Weak, irregular, or absent pulse.

(7) Irregular heartbeat or cardiac arrest.

(8) Blood pressure elevated or low with signs and symptoms of shock.

(9) Shallow, irregular, or absent breathing (tongue may swell and obstruct airway).

(10) Multiple fractured bones and dislocations from intense muscular contractions or from falling.

(11) Seizures.

d. **Effects on the Body.** Electric current can have a variety of effects on the body. Some damage can be seen immediately while other effects may not become apparent until later (after 24 hours). Examples of delayed effects include damage to the spinal cord and cataracts. Generally, the body is affected in the ways listed below.

(1) Broken bones and bruises. Alternating current, more dangerous than direct current, may cause muscular contractions that throw the victim clear of the point of contact. In the fall, however, he may sustain injuries such as bruises or broken bones.

(2) More muscular contraction damage. Muscular contractions may cause blood pressure to skyrocket suddenly. The contractions may cause the patient to have minute spots of brain hemorrhage, hemorrhage of organs, and eye disorders. One or both eyes may be bloodshot.

(3) Temporary paralysis. The patient may experience temporary paralysis. This may be the result of extensive neurological damage from the electric current passing through the cells of the body. Paralysis may cause the patient's respirations to stop.

(4) Heart. Effects of an electrical shock on the heart range from temporary fibrillation to complete cardiac arrest or permanent tissue damage. If electric current passes through the heart, death may occur immediately due to ventricular fibrillation or the temporary suspension of breathing (apnea). Cardiopulmonary arrest is the most frequent cause of death at the scene.

(5) Kidneys, spinal cord, and brain. Kidneys, spinal cord, and brain are often severely damaged.

(6) Entry wound/exit wound. The entry wound is the place where electricity entered the body. The exit wound is where electricity left the body. The entry wound is usually a blood-deprived, whitish-yellow, coagulated area. Sometimes this wound will be charred or depressed with well-defined edges. The exit wound normally looks as if the electric current exploded as it left the body.

(7) Skin. Skin damage may vary from small circular spots to large areas of charred destruction.

(8) Blood vessels. Blood vessels supplying the skin are often destroyed. Blood clots may be seen for some distance surrounding the original wound. A limb that initially seems to be only minimally damaged may become deprived of blood in a few days and, finally, become gangrenous.

(9) Late-appearing complications. Additional complications that may not appear immediately include the following:

(a) Nerve damage.

(b) Severe pain along nerve channels.

(c) Spinal cord lesions and injuries.

(d) Cardiac abnormalities.

(e) Rapid heartbeat for several weeks.

(f) Pulmonary infection.

(g) Death of muscle tissue.

(h) Muscle lesions.

(i) Delayed hemorrhage.

(j) Gastric or duodenal ulcers.

(k) Bleeding in the gastrointestinal tract.

(l) Acute kidney failure.

(10) Pregnancy. In a pregnant woman, the fetus is susceptible to electric current since the placenta and amniotic fluid provide little resistance. Even a minor shock can be serious to a fetus. Any pregnant woman who has sustained a shock, no matter how small, **must** be transported to the hospital.

e. **Protecting Yourself During Rescue.** Be very careful when you attempt to help a victim of electrical current. Sites of electrical accidents are very hazardous! To protect yourself, follow these guidelines.

(1) Look. Look for downed wires whenever the accident involves a vehicle which has struck a power pole.

NOTE: To determine whether a downed wire might be hidden in the grass or brush, carefully look at the next pole down the line. Count the number of power lines at the cross arm. There should be the same number of lines at the top cross arm of the damaged pole as at the top cross arm of the next pole. If there are not, inspect the area closely for downed power lines.

(2) Avoid downed wires. **Never** attempt to move downed wires.

(3) Radio for help. Radio for help from the power company **immediately** upon entering the scene of a downed power line.

(4) Downed line across vehicle. If a downed power line is lying across a wrecked vehicle, do not touch the vehicle--even if the victims inside are seriously injured. If the victims are conscious, tell them not to leave the vehicle. If they touch the ground and the car at the same time, the electric current may kill them.

(5) Downed line not on vehicle. If a downed power line is in the area but is not near or touching the vehicle, proceed as usual with extrication of the persons inside.

(6) Downed line sparking/flipping. If a downed power line is sparking and flipping around, use extreme caution. If the fire department is on the scene, try to throw a folded salvage cover or fire hose on the wire. As a last resort, try to roll a spare tire over the line, but **do not** touch the tire as it rolls.

(7) Downed household current line. If the downed wire is for a household current, you can handle the wire safely in **dry weather** if you wear rubber gloves or use a folded dry sheet or wooden stick. **Do not** attempt to move even a household current line if the weather is humid.

**CAUTION:** Remember, truly dangerous wiring is always placed at the top of the pole**.**

(8) Downed TV/telephone line. If the downed lines are television or telephone lines, you can handle them safely with gloved hands, even if the lines are slightly moist.

(9) Doubt about downed line. When in doubt, **do not** touch a downed line. **Never** assume that a downed line is dead unless the power company confirms this as fact.

(10) Low voltage. Relatively low voltages such as 120 volt household current can cause extensive injury to a person. The patient may look as if he has sustained just a minor injury. Therefore, be careful when you approach a patient at a site where the injury might have been caused by electricity.

NOTE: If you have a possible pool-drowning patient, check quickly in the water for electrical cords or hazards. Before you enter the water to remove the patient, brush lightly against the water. If you feel a tingle, turn off all the power at the main switch before you enter the water.

(11) Scene evaluation. Make a visual sweep of the accident scene before you attempt to treat the patient. Look for power cords and what they are attached to. Especially, look for power cords that may be routed to a tool the patient may still be holding.

(12) Plugged appliance. Pull the plug of any appliance which you believe may have shocked the patient.

f. **Treatment for an Electrical Injury Patient.** Emergency treatment begins with separating the patient from the electric current source, quick assessment of vital functions, and emergency measures such as cardiopulmonary resuscitation and defibrillation. Remember, it is vitally important in treating electrical burn casualties to maintain the patient's airway and to monitor his cardiac status. Follow the procedure given below.

(1) First, protect yourself and the patient. Be sure you are both in a safe zone, an area free from active electric current.

(2) Immobilize the patient's spine, if possible, before you move him.

(3) Start cardiopulmonary resuscitation (CPR) immediately, if indicated.

(4) Maintain the patient's airway.

(5) Evaluate and treat any burns. Cool burn sites and apply moist, sterile dressings.

(6) Treat the patient for shock and administer oxygen.

(7) Monitor the patient's cardiac status.

(8) Force the patient to lie down and keep quiet. Maintain his body temperature.

(9) Give IV fluids.

(10) Transport the patient immediately.

NOTE: Perform a urinary catheterization. Tissue death may cause the urine to be cherry-red to black colored.

## 3-5. LIGHTNING INJURIES

a. **General.** Lightning is a form of electricity, atmospheric electricity. The patient's body does not hold an electrical charge from the lightning; therefore, it is safe to touch him in order to treat him. Generally, the longer an individual is in contact with the lightning, the more serious his injuries. Always assume that a victim of a lightning strike has sustained multiple injuries, including spinal cord injuries.

b. **Body Injuries.** Electric current can cause these problems:

(1) Nervous system. The patient may be unconscious initially. He may also suffer partial paralysis or respiratory paralysis.

NOTE: Fixed and dilated pupils are a normal reaction and not necessarily a poor diagnosis.

(2) Sensory system. The patient may show loss of sight, hearing, or speech. Tympanic rupture may occur, causing a small amount of blood to drain from the ears.

(3) Skin. Lightening causes a burn that typically is mottled, feathery, or patchy. It appears in a scattered pattern over the skin and looks like tiny flowers.

(4) Heart. Cardiac damage is common. Most serious injury occurs when the current crosses the heart. The current can disrupt the heart's rhythm or cause the coronary arteries to go into spasm.

(5) Vascular system. The patient may become unresponsive, appear white and mottled, have cool arms and legs, and lose pulses. If the injury is moderate, the condition will correct itself quickly. In severe cases, the blood will coagulate and tissues in the arms and legs may die, leading to eventual amputation. The patient may have renal failure.

c. **Treatment for Lightning Injury.** Follow the procedure given below.

(1) Assess breathing and circulation.

(2) Start CPR immediately if there is no pulse. Victims of lightning have been resuscitated as long as thirty minutes after the strike without any residual damage.

(3) If the injury occurred in an open area, move the patient to a protected area to reduce the chance of a second strike. If a group of people have been struck by lightning, disregard normal triage procedure and care for the apparently dead first. Those who display vital signs will probably recover spontaneously.

(4) Survey the scene and assess what happened.

(5) Get a brief history if witnesses are available.

(6) Stabilize the patient's neck.

(7) Check the patient's skin color.

(8) If the patient is conscious, check movement in his extremities.

(9) Determine the patient's reaction to pain.

(10) Examine the patient for open wounds or fractures and provide appropriate care.

(11) Control external bleeding.

(12) Start an IV with $D_5W$.

## 3-6. CHEMICAL INJURIES

a. **General.** Chemical burns, as previously mentioned, are caused when the skin comes in contact with a caustic substance, a substance capable of burning, corroding, or destroying living tissue. Such substances include acids, alkalis, white phosphorus, and napalm. The depth of a chemical burn depends on how strong the chemical is and how long the chemical has been in contact with skin. If the chemical contains phosphorus, glowing particles may be seen on the casualty's skin. Burning will continue as long as the chemical is on the skin.

b. **Immediate Care.** Chemical burns are the only type of burn that requires immediate care of the burn wound. The chemical **must** be washed from the body surface as soon as possible.

c. **Phosphorus.** Many antipersonnel weapons used in modern warfare contain white phosphorus. Phosphorus ignites on contact with air. Fragments of phosphorus from these weapons may be driven into soft body tissue. Most skin injuries from phosphorus burns, however, are caused by clothing catching on fire. This results in conventional thermal burns.

d. **Treatment.** The goal is to remove all contaminating chemicals from the patient's body--chemicals on his skin, chemicals embedded in his body, or chemicals in clothes touching his body. Chemicals in contaminated clothing left on the patient will continue to burn him. Follow the procedures and guidelines given below

(1) Initial treatment. Speed is essential. Remove the patient's contaminated clothing. Then, immediately begin flushing the area of a chemical burn with water. Be careful not to contaminate yourself.

(2) Antidote. After an initial flushing for five minutes, remove the patient's clothing rapidly. Douse the patient again with water containing chemical antidote. Possible antidotes include diluted vinegar for alkali burns and baking soda (one teaspoon per pint of water) for acid burns.

(3) Eye care. If the patient's eyes have been involved, flush with copious amounts of water. Be sure to rinse under the patient's eyelids. (Have the patient remove contact lenses before you begin flushing with water.)

**CAUTION:** NEVER use a chemical antidote in the eyes.

(4) Evacuation. Transport the patient to a medical treatment facility.

e. **Special Cases of Chemical Burns.**

(1) Dry lime chemical burn. When combined with water, dry lime produces a highly corrosive substance. To treat a patient burned by this substance, remove the patient's clothing. Brush the lime from the skin (unless large quantities of water, such as from a garden hose, are available for immediate flushing).

(2) Phenol (carbolic acid). This substance is not water-soluble and will not be removed well by water irrigation. It is alcohol-soluble and should be washed with any available alcohol product prior to prolong flushing with water. (If alcohol is not available, use water for flushing.)

## 3-7. INHALATION INJURIES

a. **General Information.** More than half of all fire related deaths are caused by smoke inhalation. Eighty percent of those who die in residential fires do so because they have inhaled heated air, smoke, or other toxic gases. The substance inhaled by the patient can burn the respiratory tract causing potentially lethal results.

b. **Causes.** Three causes of inhalation injury are heat inhalation, inhalation of toxic chemicals or smoke, and inhalation of carbon monoxide gas. A thermal burn patient who was in an enclosed space is liable to also have an inhalation injury.

c. **Severity of Inhalation Burn.** These factors determine the severity of an inhalation burn:

(1) Products of combustion (what the products were).

(2) Degree of combustion (how complete the combustion was).

(3) Duration of exposure (how long the patient was exposed).

(4) Whether the person was in an enclosed space.

d. **Effects on the Body.** The effects on the body of inhaled toxic substances include the following.

(1) Internal damage. When noxious fumes are inhaled, mucosa in the lungs swell and break. This results in fluid leaking into the nearby alveolar spaces and damaging the cilia. Mucus builds up and plugs the air passages. This may lead to reduced oxygen exchange and, if left untreated, death.

(2) Cause of death. The usual cause of death in inhalation cases is from pneumonia. An immediate death is often caused by respiratory edema; therefore, edema is the greater concern when you are caring for an inhalation patient.

(3) Carbon monoxide poisoning. Carbon monoxide poisoning is a major cause of death at the scene of a fire. Even when it is not the cause of death, it can cause long term neurological damage by depriving the brain of oxygen.

NOTE: Almost anything gives off carbon monoxide when it burns. It is colorless, odorless, and tasteless, making it difficult to detect.

(4) Unconscious patient. If an inhalation victim is unconscious, assume he is suffering from carbon monoxide poisoning.

(5) Conscious patient. Consider carbon monoxide poisoning if the patient shows the following signs and symptoms.

(a) Headache and weakness.

(b) Nausea and/or vomiting.

(c) Loss of manual dexterity.

(d) Acts confused, lethargic, irrational, or reckless.

(6) Very late signs of carbon monoxide poisoning. Included are cherry-red coloring of the unburned skin, changes in coloration of the mucous membranes, unconsciousness, and obvious neurological damage. Do not wait for these signs since cherry-red coloring may not occur until after death.

e. **Signs and Symptoms of Carbon Monoxide Poisoning.** Suspect carbon monoxide poisoning if you observe the following:

(1) Edema of the face and neck.

(2) Singed nasal hairs.

(3) Carbonaceous sputum (caused by the death of lung tissue).

(4) Burned mucosa in the mouth and throat (redness, swelling).

(5) Sooty smell to the breath.

(6) Dyspnea.

(7) Hoarseness.

(8) Stridor (a harsh, shrill respiratory sound), a medical emergency if present.

(9) Depressed mental activity.

f. **Treatment of Inhalation Injury.** When treating inhalation injury patients, remember to assess the airway continually. Generally, follow these guidelines.

(1) Remove the patient from the area and place him in an area with fresh air.

(2) Clear the airway immediately.

(3) Administer humidified oxygen (100 percent) to minimize damage by the scorching heat.

(4) If the patient is alert and has adequate blood pressure, place him in an upright position. In this position, gravity helps reduce fluid retention in his tissues, and he can breathe easier.

(5) Mouth to mouth or mouth to mask ventilation may be required.

(6) If there is respiratory distress, insert an airway.

(7) Remove any clothing that may restrict his chest movement or breathing.

(8) Evacuate the patient to a medical treatment facility.

## 3-8. RADIANT BURNS

The body damage caused by radiation depends on the following six factors:

a. The amount and type of shielding the person used.

b. The strength of the radiation source.

c. The distance the person was from the radiation source.

d. The type of radiation.

e. How long the patient was exposed.

f. How much of his body was exposed.

NOTE: For more information on radiation burns, see MD0587, Immunizations and Environmental Injuries.

## Section III. THERMAL BURNS

### 3-9. GENERAL INFORMATION

Thermal burns generally damage the skin, an organ vital to our survival. The skin acts as a protective barrier against infection and water loss, a body temperature regulator, and a sensory organ for touch, pain, temperature, and pressure perception. Thermal burns can damage this protective barrier. The result can be loss of body temperature control, loss of body fluids and water, and susceptibility to infection. Repair of the skin is critical in maintaining body health. To treat thermal burns successfully, the degree of the burns, the percent of the body area burned, and the severity of the burns must be determined.

### 3-10. DETERMINING THE DEPTH OF THERMAL BURN (DEGREE OF THICKNESS)

The true depth of a thermal burn injury can be determined with certainty only by examining the tissue. During resuscitation of the patient, the primary concern is the total percentage of skin surface involved in second-degree and third-degree burns. Later, this information will be useful in determining treatment; for example, whether or not there is a need for skin grafts to close the wound. However, you are initially concerned with the amount of skin surface burned. Most thermal burns are a combination of first-degree, second-degree, and third-degree burns.

a. **First-Degree Burn (Mild Partial Thickness Burn).** A first-degree burn (figure 3-1) is a superficial injury involving only the outer layer of skin, the epidermis. A common example of first-degree burn is sunburn. As in sunburn, a first-degree burn is very painful. Typical characteristics are reddened skin which is dry and warm to the touch without blisters. These burns usually heal on their own in two to five days without scars. The outer layers may peel. The name "partial thickness" comes from the fact that the burn extends only partially through the epidermis, the first skin layer. Usually, first-degree burns are not included in an estimate of the total body surface area (TBSA) burned. The reason is that these burns cause no loss of skin function even though a person with first-degree burns may feel ill and have a body temperature a little above normal. (The exception is that the TBSA of first-degree burns is important when the severity of the burn is being determined. See paragraphs 3-11f, 3-12c, and 3-13c.)

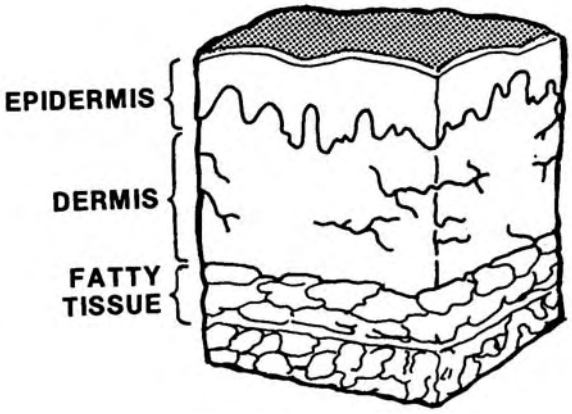


Figure 3-1. First-degree burn.

b. **Second-Degree Burn (Partial Thickness Burn).** Second-degree burns (figure 3-2) extend into, but not through, the second layer of skin (the dermis), giving these burns the name "partial thickness." The color of the burn varies depending upon its depth. Deep burns may be dark or pale and colorless. Burns of less depth may be pink or red and blotchy. The sensitivity of these burns also varies, depending on the depth of the burn. A superficial second-degree burn can be very painful and sensitive to touch and air movement. A deeper second-degree burn can have normal or decreased sensation to touch. A second-degree burn that is very deep may be hard to distinguish from a third-degree burn and may have no sensation. The most common condition is that the burn is very painful. Slight pressure or air movement causes intense pain. Swelling and blistering occur for about 48 hours after the injury. Usually, second-degree burns heal in 14 to 30 days, frequently without scarring.

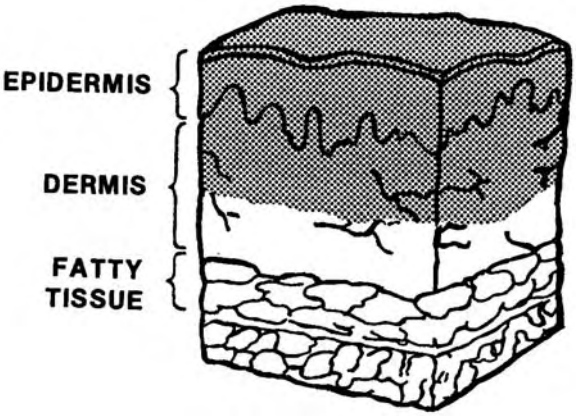


Figure 3-2. Second-degree burn.

c. **Third-Degree Burn (Full Thickness Burn).** Third-degree burns (figure 3-3) are also known as full-thickness burns because they involve the full thickness of the epidermis and the dermis. The burns may look yellow-brown, dark red, charred, or white and translucent. Those with red-colored areas will not blanch. The nerves in the deeper layers of the dermis have been destroyed; therefore, unlike the first- and second-degree burns, there is no pain or sensation in the burned areas. The skin is dry, firm, and leathery. The burn has caused the skin to lose its normal elasticity, thus restricting movement. A third-degree burn on a large part of the chest wall can limit lung expansion. A third-degree burn around an arm or a leg can constrict blood flow. These burns usually heal with scars or require skin grafts to heal. Unless the body surface burned is small, a third-degree casualty requires hospitalization.

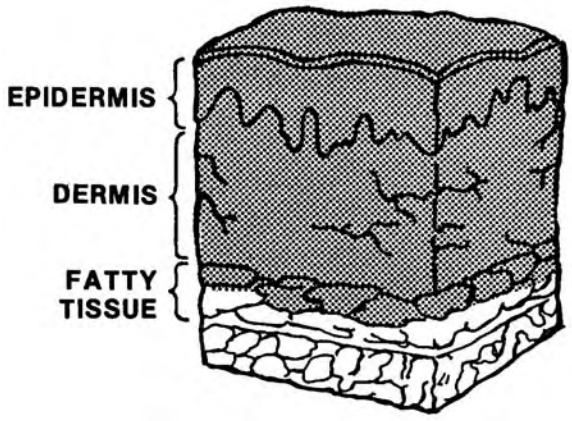


Figure 3-3. Third-degree burn.

NOTE: A burn that involves muscle or bone as well as subcutaneous tissue is sometimes classified as fourth-degree burn. Electrical burns can damage muscle or bone as the current travels through the body.

NOTE: Those areas of thermal injury that are waxy-white, soft and pliable, yet nonpainful formerly were regarded as full-thickness injuries, but are really deep partial-thickness burns. They frequently heal without the need for grafting if protected from infection. Charring with thermal injury of subcutaneous and deeper tissues is infrequent, but may occur in an unconscious victim, in individuals sustaining high voltage electric injury, in persons trapped by burning debris, or in occupants of a burning vehicle.

## 3-11. THERMAL BURNS: CRITICAL

Burns are classified according to severity as critical, moderate, or minor. The following burns are classified as critical.

a. Burns complicated by respiratory tract injuries or other major injuries or fractures.

b. Third-degree burns involving the face, hands, feet, or genital area.

c. Third-degree burns that cover more than 10 percent of an adult's body.

d. Third-degree burns that cover more than 2-3 percent of a child's body.

e. Second-degree burns that cover more than 30 percent of an adult's body or 20 percent of a child's body.

f. First-degree burns that cover more than 75 percent of the body.

g. Burns of the hands, feet, or genitalia.

h. Most chemical burns.

i. Most electrical burns.

j. Burns in patients with serious underlying medical conditions such as diabetes, seizure disorders, and hypertension.

k. Burns complicated by fracture or soft-tissue injury.

## 3-12. THERMAL BURNS: MODERATE

These following burns are classified as moderate.

a. Third-degree burns covering 2 to 10 percent of an adult's body and exclude the face, hands, feet, and genital area.

b. Second-degree burns that cover between 15 and 30 percent of an adult's body.

c. First-degree burns covering between 5 to 75 percent of an adult's body surface.

d. Uncomplicated second degree burns covering 10 to 20 percent of a child's body surface.

e. Minor burns that have complicating factors.

## 3-13. THERMAL BURNS: MINOR

Burns like the following are classified as minor.

a. Second-degree burns covering less than 15 percent of the body in an adult.

b. Second-degree burns covering less than 10 percent of the body of a child.

c. First-degree burns involving less than 20 percent of the adult or child.

## 3-14. ADDITIONAL FACTORS IN THERMAL BURN ASSESSMENT

Consider these factors when assessing the criticality of a burn:

a. **Irregular Burn Distribution.** To estimate burns that are irregularly distributed, use the fact that one surface of a casualty's hand represents about one percent of his body surface.

b. **Burns Over 15 Percent of the Body surface.** Patients with burns of more than 15 percent of the body surface typically require some resuscitative treatment. These patients are best cared for in a hospital.

c. **Location of the Burn.** Burns of the face, hands, feet, or genitalia need immediate treatment. Small burns on these areas may require hospitalization, even if these limited areas are the only sites of burn injury. Transport such patients to a medical treatment facility.

d. **Configuration of the Burn.** A burn which surrounds a body part may completely cut off circulation due to tissues swelling. For example, neck burns can result in airway obstruction and chest burns can cause breathing difficulty.

e. **Complicating Medical Problems.** Circulatory problems such as diabetes and peripheral vascular disease affect burns.

f. **Patient Age.** Young adults tolerate thermal injury best. Those under four years and over 60 years of age have more complications and a greater mortality rate for the same extent of burn that a young adult survives.

g. **Severity of Injury.** The percent of burn and the depth of burn determine the severity of burn injury. Usually, burns covering more than 20 percent of the body surface are life-threatening. Burns covering more than 30 percent of the body surface are usually fatal to adults without immediate treatment.

## 3-15. BURN DEPTH ESTIMATE

a. **Scald Burn.** A scald on the bare skin of an adolescent or an adult is probably superficial. The reason is that heat dissipates rapidly. In a child or an elderly person, the burn may involve the additional dermal layers of skin.

b. **Hot Grease Burn.** A burn caused by hot grease is probably a full-thickness burn. This is because grease cools slowly and is difficult to remove. Hot grease on the skin may cause extensive and deep damage before anyone can get it off the skin.

c. **Electricity/Chemical Burns.** Burns caused by electricity or chemicals are almost always full-thickness burns.

## 3-16. THERMAL BURNS: THE RULE OF NINES

The severity of thermal injury depends on the depth and extent of the burn. These two factors determine not only mortality and initial treatment requirements, but the character of healing, functional result, and the consequences on the body of the injury.

a. **The Rule of Nines.** The Rule of Nines is a quick way to calculate the amount of skin surface that has been burned. The name comes from the fact that various regions of the adult anatomy are assigned nine percent of the body surface or multiples of nine. (The Rule of Nines is also used to determine the percent of a child's skin surface with burns. The percentages assigned to a child's legs are not nines or multiples of nines.) See figure 3-4 for percentages assigned to an adult's body and figure 3-5 for percentages assigned to a child's body.

NOTE: Look at figure 3-4. Notice that although the upper extremities are listed as totaling 18% of the total body surface area with each arm being 9%, the front and back of the arms are further divided. The front of the arm is 4.5%, and the back of the arm is 4.5%. The same is true for the lower extremities. Each leg is 18%, but the leg front is 9%, and the leg back is 9%.

NOTE: See figure 3-5. Just as the body surface of an adult can be further divided, so can the body surface area of the small child. Notice that while each upper extremity equals 9%, the front of the arm is 4.5%, and the back of the arm is 4.5%. Similar subdivisions are made for the lower extremities.

**RULE OF NINES FOR ADULT BODY SURFACE BURNS**

Head and neck equal ..... 9%

Anterior trunk equals .....18%

Posterior trunk equals .....18%

Upper extremities (each 9%).....18%

Lower extremities (each 18%).....36%

Perineum..... 1%

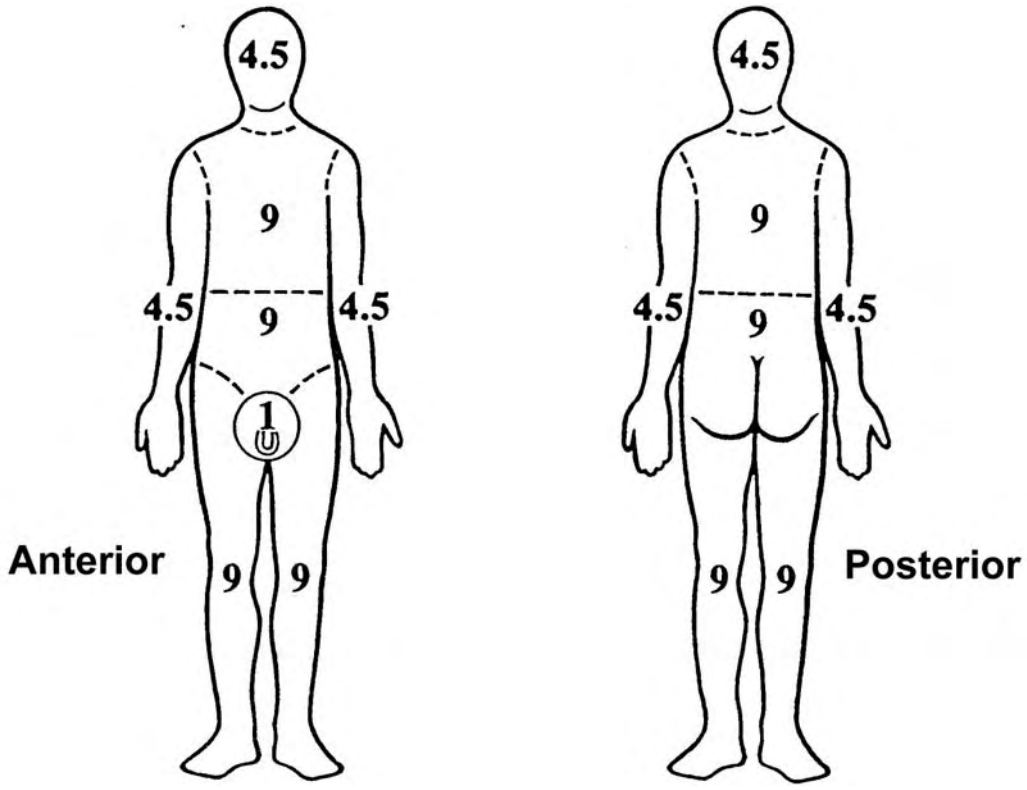


Figure 3-4. Rule of nines for adult body surface burns.

**RULE OF NINES FOR SMALL CHILD BODY SURFACE**

Head and neck equal .....18 %

Anterior trunk equals .....18 %

Posterior trunk equals .....18 %

Upper extremities (each 9%).....18 %

Lower extremities (each 13.5%)...27 %

Perineum..... 1 %

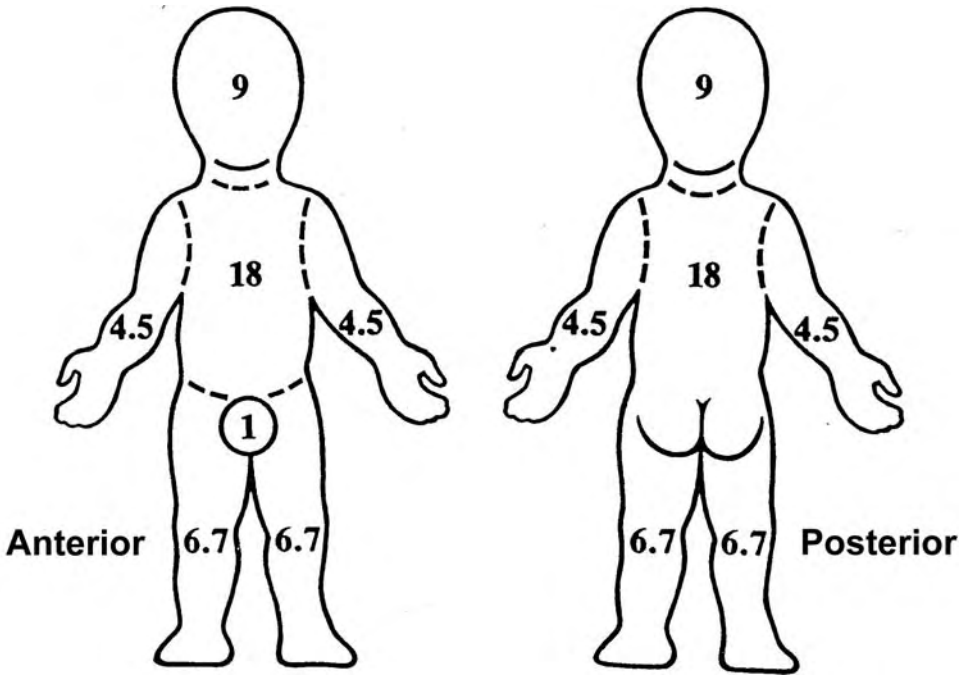


Figure 3-5. Rule of nines for small child body surface burns.

b. **Examples**. Examples of calculating the percentage of burn are given in figures 3-6 through 3-8.

**EXAMPLE #1.** A person sustained burns of the chest, abdomen, and right arm.

**PROBLEM:** What percentage of the body was burned?

**SOLUTION:**

| | | |
|---|---|---|
| Chest (anterior trunk) | = | 9.0 % |
| Abdomen | = | 9.0 % |
| front right arm | = | 4.5 % |
| back right arm | = | 4.5 % |
| | | **27.0** % |

Figure 3-6. Calculating percentage of burn, example 1.

**EXAMPLE #2.** A small child was burned on the posterior trunk, the back of the right arm, and the back of the right leg.

**PROBLEM:** What percentage of the body was burned?

**SOLUTION:**

| | | |
|---|---|---|
| Posterior trunk | = | 18.0 % |
| back right arm | = | 4.5 % |
| back right leg | = | 6.7 % |
| | | **29.2** % |

Figure 3-7. Calculating percentage of burn, example 2.

| |
|---|
| **EXAMPLE #3.** An adult is burned on the anterior trunk, the right arm, and the left arm. |
| **PROBLEM:** What percentage of the body was burned? |
| **SOLUTION:**<br>Anterior trunk = 18 %<br>Right arm (front and back) = 9 %<br>Left arm (front and back) = 9 %<br>**36 %** |

Figure 3-8. Calculating percentage of burn, example 3.

## 3-17. THERMAL BURNS: MANAGEMENT

a. **History.** Observe the scene of the injury. Find out how long the burn occurred before help arrived. Try to obtain the answers to the following questions.

(1) What has the patient or bystanders done for the injury?

(2) Was the patient in a closed space with smoke, steam, or other products of combustion? If so, for how long? Did the patient lose consciousness?

(3) What was the cause of the burn? Open flame? Hot liquids?

(4) Does the patient have any history of significant heart disease which might complicate fluid therapy? Pulmonary problems which might cause a reaction to smoke inhalation? Other underlying illnesses?

b. **General Treatment.**

(1) Remove the casualty from the source of the burn. Smother any flames and turn off the electrical source. Extinguish and cut off burning clothes. That is, generally, eliminate the cause of the burn.

(2) Maintain the airway, continually assessing for patency (making sure the airway is open).

(3) Administer humidified oxygen.

(4) Assess vital signs.

(5) Remove the patient's clothing and constrictive articles such as rings and bracelets. Clothing may continue to smolder, so cut it away. **DO NOT** pull away clothing that is stuck to the skin. Cut around the stuck clothing.

(6) Evaluate the casualty for other injuries such as hemorrhage or central nervous system injury.

(7) Treat for shock. Start an IV to replace body fluids. Use a large-bore catheter. For burns that are greater than 20 percent of the TBSA and for significant electrical burns, perform gastric intubation. (Later in this lesson, you will be instructed how to determine the amount of fluid to give, depending on the casualty's body weight and the total body surface area burned.)

(8) Perform urinary catheterization if the burns are greater than 20 percent of the body surface and the patient has significant electrical burns.

(9) Keep the casualty warm at all times.

(10) Dress any wounds and provide psychological support, and pain control with narcotics if possible.

**CAUTION:** NEVER USE ointments, butter, cream, salves, sprays, or any other covering on any type of burn. These will have to be scrubbed off later and will further irritate the burn and cause the patient pain.

## 3-18. SPECIALIZED TREATMENT

a. **First-Degree Thermal Burns.** Treat these burns with running cold water if you reach the burn within the first hour of injury and the total body surface area is less than 10 percent. Any burn of greater body surface area (BSA) should not be cooled in the field due to the possibility of hypothermia. Burns of greater than 10 percent TBSA should be covered with dry sterile dressings.

b. **Second-Degree Thermal Burns.** These burns are treated very much the same as first-degree burns. Leave blisters intact. Start an IV if the second-degree burns cover more than 15 percent of the patient's body accompanied by first-degree burns covering more than 30 to 50 percent of the body.

c. **Third-Degree Thermal Burns. DO NOT** immerse such burns in cold or lukewarm water. Cover the burn with a dry sterile dressing. Then, cover the casualty with a blanket that will not stick to the burn area. Anticipate problems if the patient has facial burns, has been exposed to smoke or hot gases, has been unconscious in a burning area, coughs up sooty sputum, or has hoarseness, stridor, or a brassy cough. Evacuate the casualty immediately. If evacuation is delayed, it may be necessary to cleanse the burn area and remove any foreign particles. A topical antibacterial ointment (silver sulfadiazine is preferred) can be applied well after the burning process has stopped. This step will usually not be done in the pre-hospital setting.

NOTE: A major problem in the severely burned patient is acute gastric distention. If the patient is intubated, insert a nasogastric tube to decompress the stomach. **DO NOT** attempt to insert a nasogastric tube if the patient is comatose or stuporous and not yet intubated or in a patient who has had severe thermal injury involving the nasopharynx.

## 3-19. ADDITIONAL CONCERNS

Be aware of the following when treating a burn patient.

a. Look for associated injuries. If a patient shows signs of hypovolemia in the early stages after a burn, then the patient has other injuries.

b. Check the eyes and cover them with moist sterile pads.

c. Check pulses of the extremities. Circumferential burns may act as a tourniquet to block the patient's circulation.

d. For a patient with third-degree burns covering more than 10 percent of the body (or with extensive burns of varying degrees), start an IV. Hang Plasmamate® or a similar colloid, if available.

e. **DO NOT** waste time picking debris off the patient's skin. Cover him with a sterile sheet or clean dressings. Areas with equal burn depth should be covered with cold, soaked towels.

f. Remove bracelets, rings, and such since edema will soon follow the burn.

g. Treat associated fractures, lacerations, and other injuries.

## Section IV. FLUID REPLACEMENT AND MEASUREMENT OF URINE OUTPUT

### 3-20. REPLACE FLUIDS

Almost immediately after a severe burn injury, many physiologic changes occur in the body. One change involves fluid in the body. After a burn, body fluid moves toward the burned area, which is the reason for some swelling at the burn site. Some of this fluid is then trapped in the burn area, which means that fluid is not available for use elsewhere in the body. The result is fluid loss in the body. Fluid is also lost from the burned area in the form of water vapor and seepage. Sometimes, large amounts of water are lost. For the body to function normally again, the lost fluids must be replaced.

### 3-21. CALCULATE FLUID AMOUNT

a. **Calculation.** To calculate the amount of fluid the casualty needs, use the modified Brooke formula (figure 1-9). Use this formula when treating a casualty during the first 24 hours after a burn. Remember, using any formula to determine a casualty's fluid volume requirement is an estimate. Be sure to monitor the casualty's fluid intake and output as well as his pulse, respirations, blood pressure, and general appearance. Make appropriate changes in the amount of fluid being given the casualty as needed. Replacing the fluids a person with a burn injury has lost is called fluid resuscitation.

STEP 1. Determine the total body surface area (TBSA) that is burned.

STEP 2. Calculate the casualty's weight in kilograms (divide pounds by 2.2).

STEP 3. Calculate and replace fluids using this formula:

| | | | | | | |
|---|---|---|---|---|---|---|
| Fluid* | = | 4cc Ringer's lactate | X | percent TBSA burned | X | weight in kilograms |

NOTE: Fluid* is the fluid to replace in the first 24 hours after the burn.

NOTE: Use the TBSA number without the percent when working the formula. For example, if the TBSA is 45 percent; then multiply by 45.

STEP 4. Replace the amount of fluid determined in Step 3 as follows:

(a) During the first 8 hours give one-half of the total calculated fluids.

(b) During the second 8 hours, give one-fourth of the total calculated fluids.

(c) During the third 8 hours, give one-fourth of the total calculated fluids.

Figure 3-9. Modified Brooke formula.

b. **Examples.** Examples of calculating fluid replacement are given in figures 3-10 through 3-13.

**EXAMPLE #1.** The patient is a 24 year old male who was burned by a chemical. He sustained second- and third-degree burns covering 35 percent of his body. He weighs 165 pounds.

**PROBLEM:** Calculate the fluid resuscitation needed for the first 24 hours. How much fluid should he receive in the first 8 hours?

**SOLUTION:**

STEP 1. TBSA burned is 35 percent.

STEP 2. 165 lbs divided by 2.2 = 75 kg (weight in kg)

STEP 3. Calculate by formula:

**4cc** X **TBSA** X **weight in kgs = fluid**

**4** X **35** X **75** = **10,500 cc** (in first 24 hours.

STEP 4. Calculate fluid replacement in first 8 hours.

Half of first 24-hr fluid replacement

**10,500 divided by 2 = 5,250 cc** (fluid replacement in first 8 hours)

Figure 3-10. Calculating fluid replacement, example 1.

**EXAMPLE #2.** The patient is a 22 year old female who was burned in a house fire. She sustained second- and third- degree burns covering 70 percent of her body. She weighs 130 pounds.

**PROBLEM:** Calculate the fluid resuscitation needed for the first 24 hours. How much fluid should she receive in the first 16 hours?

**SOLUTION:**

STEP 1. TBSA burned is 70 percent.

STEP 2. 130 lbs divided by 2.2 = 59 kg (weight in kg)

STEP 3. Calculate by formula:

**4cc** X **TBSA** X **weight in kgs = fluid**

**4** X **70** X **59** **= 16,520 cc** (in first 24 hours.

STEP 4. Calculate fluid replacement in first 16 hours.

First 8 hrs. Half of first 24-hr fluid replacement

**16,520 divided by 2 = 8,260 cc** (fluid replacement in first 8 hours)

Second 8 hrs. Fourth of first 24-hr fluid replacement

**16,520 divided by 4 = 4,130 cc** (fluid replacement in second 8 hours)

8,260 cc + 4,130 cc = **12,390 cc** fluid replacement in first 16 hours)

Figure 3-11. Calculating fluid replacement, example 2.

**EXAMPLE #3.** A male casualty has sustained second- and third-degree burns over 35 percent of his body. He weighs 180 pounds.

**PROBLEM:** Calculate the fluid resuscitation needed for the first 24 hours. Calculate the amount of fluid to be given in each of the three 8 hour periods.

**SOLUTION:**

STEP 1. TBSA burned is 35 percent.

STEP 2. 180 lbs divided by 2.2 = 81.8 kg (weight in kg)

STEP 3. Calculate by formula:

**4cc** X **TBSA** X **weight in kgs = fluid**

**4** X **35** X **81.8** **= 11,452 cc** (in first 24 hours.

STEP 4. Calculate fluid replacement in each 8 hr period.

First 8 hrs. Half of first 24-hr fluid replacement

**11,452 divided by 2 = 5,726 cc** (fluid replacement in first 8 hours)

Second 8 hrs. Fourth of first 24-hr fluid replacement

**11,452 divided by 4 = 2,863 cc** (fluid replacement in second 8 hours)

Third 8 hrs. Fourth of first 24-hr fluid replacement

**11,452 divided by 4 = 2,863 cc** (fluid replacement in third 8 hours)

(Check: 5,726 cc + 2,863 cc + 2,863 cc = 11,452 cc)

Figure 3-12. Calculating fluid replacement, example 3.

**EXAMPLE #4.** A 35-year-old female has been burned by a chemical and has second- and third-degree burns over 25 percent of her body. She weighs 115 pounds.

**PROBLEM:** Calculate the fluid resuscitation needed for the first 24 hours. Calculate the fluid needed for the 2nd and the 3rd 8-hour periods.

**SOLUTION:**

STEP 1. TBSA burned is 25 percent.

STEP 2. 115 lbs divided by 2.2 = 52 kg (weight in kg)

STEP 3. Calculate by formula:

**4cc** X **TBSA** X **weight in kgs = fluid**

**4** X **25** X **52** **= 5,200 cc** (in first 24 hours.

STEP 4. Calculate fluid replacement for second and third 8-hr periods.

Second 8 hrs. Fourth of first 24-hr fluid replacement

**5,200 divided by 4 = 1.300 cc** (fluid replacement in second 8 hours)

Third 8 hrs. Fourth of first 24-hr fluid replacement

**5,200 divided by 4 = 1.300 cc** (fluid replacement in third 8 hours)

Figure 3-13. Calculating fluid replacement, example 4.

## 3-22. MEASURE URINE OUTPUT

In the first 24 hours, urine output should **NOT** be greater than 60 cc per hour. The only exception is the output of an electrical burn casualty who has gross myoglobinuria (the cherry-red or black-colored urine caused by dying muscle tissue). Urine output for this casualty should be as high as needed to achieve normal-color urine. When normal-color urine is attained, urine output should be held between 30 to 60 cc per hour. The most important limits for adequate fluid resuscitation are adequate urine output defined as not less than 30 cc per hour; clear sensorium (the state of being mentally alert and conscious); and blood pressure which is normal for the casualty. Urine output requirement for the second 24-hour period is much less than the first 24-hour period. Adequate urine output of no more than 30 cc per hour should be maintained. Consider fluid replacement on an individual basis after deciding the amount of fluid the casualty is losing and checking laboratory test results.

# Section V. TOPICAL ANTIMICROBIAL DRESSINGS

## 3-23. GENERAL INFORMATION

In an area where aseptic conditions prevail after a patient's burn has been treated, an appropriate topical agent can be applied. The burn is then covered with sterile dressings. There are several types of dressings that can be used on burns. The most common are silver sulfadiazine (Silvadene®), mafenide acetate (Sulfamylon®), and silver nitrate soaks. Each treatment has advantages and disadvantages. Look at the advantages and disadvantages of each agent.

## 3-24. SILVER SULFADIAZINE (SILVADENE®)

a. **Advantages.** Silver sulfadiazine is most effective when it is applied to burns immediately after the thermal injury. A broad antimicrobial agent that can penetrate a eschar, silver sulfadiazine is pain-free and clear so that the burn area remains visible. (The eschar is the dead skin caused by the burn.) An occlusive dressing is not required when this medication has been applied. The treatment is compatible with treatments for other injuries and the medication does not impede motion of the joints.

b. **Disadvantages.** The medication does NOT penetrate through dead skin that resulted from the burn. This may cause a delay in epithelialization (the final stage of healing of a surface burn). Bone marrow is suppressed. Some people experience hypersensitivity reactions. Eschar (scab) separation is delayed. Certain gram-negative organisms are resistant to this medication. The medication causes tattooing of the skin, so it should not be used on the face or other areas that may be cosmetically important.

## 3-25. MAFENIDE ACETATE (SULFAMYLON®)

a. **Advantages.** This medication is the best choice for treating a highly contaminated wound. Sulfamylon® penetrates through eschar. After application, the wound is visible. This medication has broad anti-gram negative activity and does not impede the motion of joints.

b. **Disadvantages.** There are several disadvantages to using mafenide acetate. First, use of this medication tends to cause the casualty to hyperventilate. That is, the casualty breathes too deeply and upsets the carbon dioxide balance in his body. This results in the casualty experiencing buzzing in the ears, tingling of the lips and fingers, and sometimes fainting. Secondly, mafenide acetate is very painful when applied or removed. Thirdly, this medication may delay the formation of new tissue. Finally, the casualty may be hypersensitive to this medication.

## 3-26. SILVER NITRATE DRESSING

a. **Advantages.** Use this treatment if topical, antimicrobial creams are not available. Apply multi-layered occlusive gauze dressings. Change the dressings two to three times a day, moistening the dressings every two hours to prevent the dressings from becoming dry. Silver nitrate soaks have broad, anti-gram-negative activity. This medication decreases the wound heat loss.

b. **Disadvantages.** Application of the medication on the burn area is painful. The medication does not penetrate the eschar. The soaks promote electrolyte imbalance by causing losses of sodium, potassium chloride, and calcium. Dressings impair joint motion and retain heat. The soaks discolor the skin and the surrounding environment. These dressings, sometimes called silver nitrate soaks, are often ineffective when used on a wound that has an established infection.

## 3-27. CLOSING

Burns are among the most potentially dangerous and most common life-threatening injuries. A casualty with burns needs immediate treatment. Proper knowledge and prompt treatment for burns could save a life.

**Continue with Exercises**

**EXERCISES, LESSON 3**

**INSTRUCTIONS.** The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers.

1. List six factors to consider when you determine the severity of a burn injury.

   a. _____.

   b. _____.

   c. _____.

   d. _____.

   e. _____.

   f. _____.

2. Most thermal burns are caused by _____

3. Acids, alkalis, napalm, and white phosphorus coming in contact with the body can cause _____ burns.

4. What is the most frequent cause of death at the scene when electric current has passed through a person? _____.

5. List four late-appearing complications which may follow an electrical injury to a person.

   a. _____.

   b. _____.

   c. _____.

   d. _____.

6. What is a good way to decide if there is a downed electrical wire hidden in tall grass or brush? _____

   _____.

7. What are the initial emergency treatment procedures forf a person who has had an electrical injury?

   a. _____.

   b. _____.

   c. _____.

8. An individual has been struck by lightning. What injuries should you assume that he has?

   _____

9. The first treatment for a patient with a chemical burn is _____

   _____.

10. What is the usual cause of death from inhalation injury? _____.

11. Why is carbon monoxide difficult to detect? _____

_____.

12. List four functions of the skin.

    a. _____.

    b. _____.

    c. _____.

    d. _____.

13. The body organ usually damaged by thermal burns is _____.

14. a. Which layer of skin does first-degree burns involve? _____.

    b. These burns are also referred to as _____ burns.

15. Second-degree burns are called partial thickness burns because they _____

_____

_____

16. a. Which layers of skin do third-degree burns damage? _____.

    b. Third-degree burns are also known as _____ burns.

17. Burns are classified according to severity. Classify each of these burns as critical, moderate, or minor in terms of severity.

    a. Second-degree burns covering 10 percent of an adult's body surface.

    _____

    b. Second-degree burns covering 15 to 30 percent of an adult's body.

    _____

    c. Third-degree burns covering more than 10 percent of an adult's body.

    _____

18 What is dangerous about a burn that surrounds the neck? _____

_____

19. Why is a hot grease burn probably a full thickness (third degree burn)? _____

_____

20. A casualty has second-degree burns on his right arm (front and back), his right leg (front and back), and his chest. What is the total body surface area (TBSA) burned?

_____

_____

21. Should you apply ointments, butter, creams, salves, or sprays on a second or third-degree burn? _____ Why or why not? _____

_____

22. Why should bracelets and rings be removed from a burn patient? _____

_____

23. SITUATION: A casualty has sustained second- and third-degree burns on the back of his head, all of his back and buttocks area, and the back of both legs. He weighs 186 pounds. Determine the following:

    a. Percent of TBSA burned. _____

    b. Body weight in kilograms (kg). _____

    c. Amount of fluid replacement needed for the first 24 hours. _____

    d. Amount of fluid to give him during the first 8 hours. _____

    e. Amount of fluid to give him during the second 8 hours. _____

    f. Amount of fluid to give him during the third 8 hours. _____

24. SITUATION: A casualty has sustained second- and third-degree burns on his chest and abdomen and the front of both arms. He weighs 155 pounds. Determine the following:

    a. Percent of TBSA burned. _____

    b. Body weight in kilograms (kg). _____

    c. Amount of fluid replacement needed for the first 24 hours. _____

    d. Amount of fluid to give him during the first 8 hours. _____

    e. Amount of fluid to give him during the second 8 hours. _____

    f. Amount of fluid to give him during the third 8 hours. _____

25. SITUATION: A casualty has sustained third-degree burns on his chest and the front and back of his head. He weighs 147 pounds. Determine the following:

    a. Percent of TBSA burned. _____

    b. Body weight in kilograms (kg). _____

    c. Amount of fluid replacement needed for the first 24 hours. _____

    d. Amount of fluid to give him during the first 8 hours. _____

    e. Amount of fluid to give him during the second 8 hours. _____

    f. Amount of fluid to give him during the third 8 hours. _____

26. Urine output for the first 24 hours after the burn should be no more than _____cc per hour. The exception is the patient with a(n) _____ burn.

27. Two advantages of using _____ to treat burns is that it is pain-free and clear when applied to the burn area.

28. A disadvantage in using _____ is that it tends to make a casualty hyperventilate.

29. If a casualty weighs 145 pounds, he weighs _____ kilograms.

30. Treatment on the burn area is silver nitrate dressings. Moisten the dressings every two hours to _____

31. SITUATION: A casualty has sustained third-degree burns on the front of his left leg and the front of his left and right arms. He weighs 157 pounds. Determine the following:

a. Percent of TBSA burned. _____

b. Body weight in kilograms (kg). _____

c. Amount of fluid replacement needed for the first 24 hours. _____

d. Amount of fluid to give him during the first 8 hours. _____

e. Amount of fluid to give him during the second 8 hours. _____

f. Amount of fluid to give him during the third 8 hours. _____

**Check Your Answers on Next Page**

## SOLUTIONS TO EXERCISES, LESSON 3

1. Source of the burn.
   Degree of the burn.
   Percentage of the body burned.
   Location of the burn.
   Complications accompanying the burn.
   Age of the patient.
   (para 3-2a through e)

2. Gasoline and other fuels igniting. (para 3-3b)

3. Chemical. (para 3-3d)

4. Cardiopulmonary arrest. (para 3-4d(4))

5. You are correct if you listed any four of the following:

   Nerve damage
   Severe pain along the nerve channels
   Spinal cord lesions and injuries
   Cardiac abnormalities
   Rapid heartbeat for several weeks
   Pulmonary infection
   Death of muscle tissue
   Delayed hemorrhage
   Gastric or duodenal ulcers
   Bleeding in the gastrointestinal tract
   Acute kidney failure
   (para 3-4d(9)

6. Count the number of power lines at the crossarm of the next power pole. Then, the power lines at the cross arm of the pole damaged by the accident.
   (para 3-4e(1)NOTE)

7. Separate the patient from the electric current source.
   Quick assess his vital functions.
   Begin emergency measures.
   (para 3-4f)

8. Assume he has multiple injuries, including spinal cord injuries. (para 3-5a)

9. Remove all contaminated clothing. (para 3-6d(1))

10. Pneumonia. (para 3-7d(2))

11. Because it is colorless, odorless, and tasteless. (para 3-7d(3)NOTE)

12. Protects against infection.
Protects body from water loss.
Regulates body temperature.
Sensory organ for touch, pain, temperature, & pressure perception.
(para 3-9)

13. The skin. (para 3-9)

14. a. The epidermis which is the outer layer of skin.
b. Mild partial thickness burns.
(para 3-10a)

15. Extend partially into the skin layers. Second-degree burns extend through the first skin layer (epidermis) and into, but not through, the second skin layer (the dermis). (para 3-10b)

16. a. The epidermis and the dermis.
b. Full thickness.
(para 3-10c)

17. a. Minor. (para 3-13a)
b. Moderate. (para 3-12b)
c. Critical. (para 3-11c)

18. This burn can cause airway obstruction. (para 3-14d)

19. Hot grease is hard to remove and cools slowly. The grease may cause extensive damage before anyone can remove it. (para 3-15b)

20. Right arm, front = 4.5%
Right arm, back = 4.5%
Right leg, front = 9%
Right leg, back = 9%
Chest = 9%
36% TBSA burned (para 3-16a)

21. No. These will just have to be scrubbed off later, irritating the skin and causing the patient pain. (para 3-17b, CAUTION)

22. Tissues will swell soon after the burn. (para 3-19f)

23. a. 40.5%.
    b. 186 divided by 2.2 = 84.5 kg.
    c. 4 cc times 84.5 times 40.5 = 13,689 cc.
    d. 13,689 divided by 2 = 6,845 cc.
    e. 13,689 divided by 4 = 3,422 cc.
    f. 13,689 divided by 4 = 3,422 cc.
    (para 3-21a, fig 3-9)

24. a. 27%.
    b. 155 divided by 2.2 = 70.5 kg.
    c. 4 cc times 70.5 times 27 = 7,614 cc.
    d. 7,614 divided by 2 = 3,807 cc.
    e. 7,614 divided by 4 = 1,904 cc.
    f. 7,614 divided by 4 = 1,904 cc.
    (para 3-21a, fig 3-9)

25. a. 18%
    b. 147 divided by 2.2 = 66.8 kg.
    c. 4 cc times 66.8 times 18 = 4,810 cc.
    d. 4,810 divided by 2 = 2,405 cc.
    e. 4,810 divided by 4 = 1,203 cc.
    f. 4,810 divided by 4 = 1,203 cc.
    (para 3-21a, fig 3-9)

26. 60
    Electrical. (para 3-22)

27. Silver sulfadiazine. (para 3-24a)

28. Mafenide acetate. (para 3-25b)

29. 66.9 (fig 3-9 step 2)

30. Prevent the dressings from becoming dry. (para 3-26a)

31. a. 18%.
    b. 158 divided by 2.2 = 71.8 kg.
    c. 4 cc times 71.8 times 18 = 5170 cc.
    d. 5170 divided by 2 = 2585 cc.
    e. 5170 divided by 4 = 1293 cc.
    f. 5170 divided by 4 = 1293 cc
    (para 3-21a, fig 3-9)

**End of Lesson 3**